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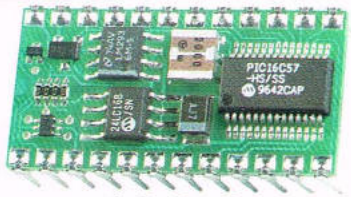

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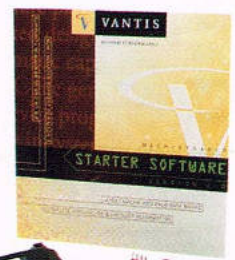

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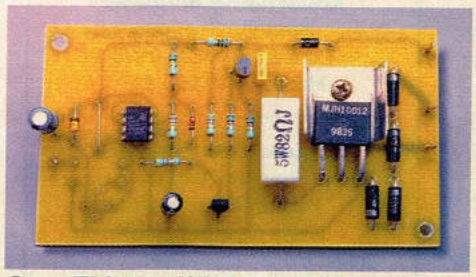

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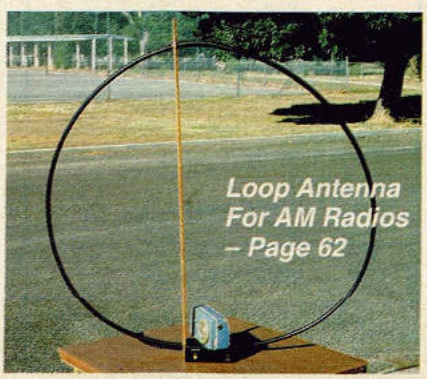

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PUBLISHER'S LETTER

Making do with old computers

This month we feature an article on making use of a standard computer power supply. There is a dearth of information on this subject and circuits for these power supplies are about as rare as copper oxide rectifiers, so all the information in the article has been gleaned from physical examination of a range of these supplies. As this stage though, we know next to nothing about their over-voltage and over-current protection and a host of other details.

So having produced the power supply article this month, we would have liked to take the subject much further and at some stage in the future we hope to do so, as we obtain more detailed information. For example, wouldn't it be a great idea if we could turn a standard 250W or 300W power supply into something really useful – like having it power a big audio amplifier.

Such a modification would not be simple though. The transformer would have to be rewound and we're not sure how much trouble that would involve since we understand that some of these transformers are wound with Litz wire (multi-strand wire with each strand separately insulated). The fast recovery rectifiers and filter components would also have to be upgraded but the end result would be very compact and efficient.

Such a 300W switchmode power supply would cost only a fraction of a conventional power supply with its large power transformer and expensive electrolytic filter capacitors. And it would have the advantage of an inbuilt fan to possibly provide cooling for the amplifier as well. If you happen to have done this sort of conversion, we'd like to hear from you.

There must be a lot of other opportunities to make use of existing consumer electronics technology which might otherwise go to the tip. Some examples might be as simple using a defunct VCR as a TV tuner, using a dot matrix printer as a scanner or maybe using a VCR as a 7-day programmable timer/controller. How about uses for a defunct microwave oven? There's all that hardware and a big (dangerous) power supply; it must have some use when the magnetron or other key component fails. Again, maybe it could be used as fancy timer.

What about some wilder suggestions? Could the transport mechanism of a defunct CD player or CD-ROM drive be used as a slow motion drive for a working model on a model railway layout? Consider that there are several drive systems employed here, for the drawer, for laser tracking and for focusing. Could the turntable drive in a microwave oven be put to a similar use? It's amazing just how many motors and drive systems are employed in modern consumer gear – how can they be used when the appliance fails?

Why not tell us your ideas for using defunct consumer appliances? Perhaps we can publish a few articles along these lines and thereby do our bit to slow the waste of good resources.

Leo Simpson

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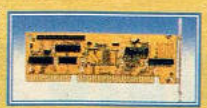

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Hifi Review

Harman Kardon Signature Series

Harman Kardon is a name long associated with high fidelity sound reproduction and they're still going strong with the release of their Signature Series – a 200 watt per channel power amplifier and a Dolby Surround Processor/ Tuner. We recently had a chance to have a close look at both of these products.

Actually there are three products in the Signature Series range, the two already mentioned and a 5-channel Surround Sound amplifier. While the two power amplifiers are fairly conventional, the Signature Series 2.0 Dolby Digital Surround Processor/ Tuner is quite different in that it packs all sorts of features into a case which has few external controls. In fact, it has just nine pushbuttons and a large knob as its control complement. The real control complexity is "hidden" and only becomes evident as you use the remote control and the menu system on the front panel display.

The remote control has quite a good layout of buttons, 61 in all, which are easy to read – an important point. The labelling on some remotes is very difficult to read, especially in subdued light and you wonder if the designers have ever used them in a typical home situation.

One feature that we particularly liked was the "sending" LED which flashes whenever you push a button. It is amazing how often a TV set or other appliance will not respond to a remote command and you immediately wonder whether the set is at fault or the remote. With this Harman Kardon remote, at least you know that it is "sending" the command.

Since this Processor/Tuner is designed to be the heart of a Surround Sound system, its remote handset should ideally control the TV set or video projector and the VCR or DVD player, as well as any other sources such as CD player and tape decks. For this reason, the remote control is a "learning" type and so it can learn all the other remote control functions. This is good because if you do have a full Surround Sound system, you don't want to be juggling three or four remote controls.

While the front panel of the Processor/Tuner is sparse, the rear panel is crammed with lots of input and output sockets to handle audio and video signals from a wide range of sources. Six pairs of audio analog (line level) sources, such as CD players and tape decks, can be selected and these can be paired with three composite video inputs or two S-video inputs. This means that sources such as hifi VCRs, DVD and laserdisc players can be fully controlled.

Up to six separate digital program sources may be connected, via four coax and two optical data inputs. As well, you can connect the six Surround Sound decoded outputs from another source (should you be so well-heeled) so that you have centralised control of everything via the remote handset. There are also two pairs of outputs for connection to tape decks and six outputs for surround sound;

The apparent simplicity of the Harman Kardon Signature Series 2.0 Processor/ Tuner belies the complexity of its features. This is reinforced by the array of input and output sockets on its rear panel.

ie, left & right front, centre, rear left & right and subwoofer.

Mind you, there is one input omission which may or may not be a drawback, depending on the program sources you normally use. If you like listening to vinyl records, you will need an external preamplifier for the magnetic cartridge signals.

As well as all the audio inputs and outputs, there are antenna connections for AM and FM stereo tuners, an RS-232 socket and sockets for IR remote and trigger control signals.

As you can imagine, when the majority of these inputs and outputs are in use, the result is a mass of cabling but the real complexity lies in the circuitry inside the Processor/Tuner. Not only does it provide Dolby Digital (AC-3) and Dolby Pro Logic processing and digital to analog decoding of purely digital sources, it also makes use of the RDS data system in use in Europe although this is of no use in Australia.

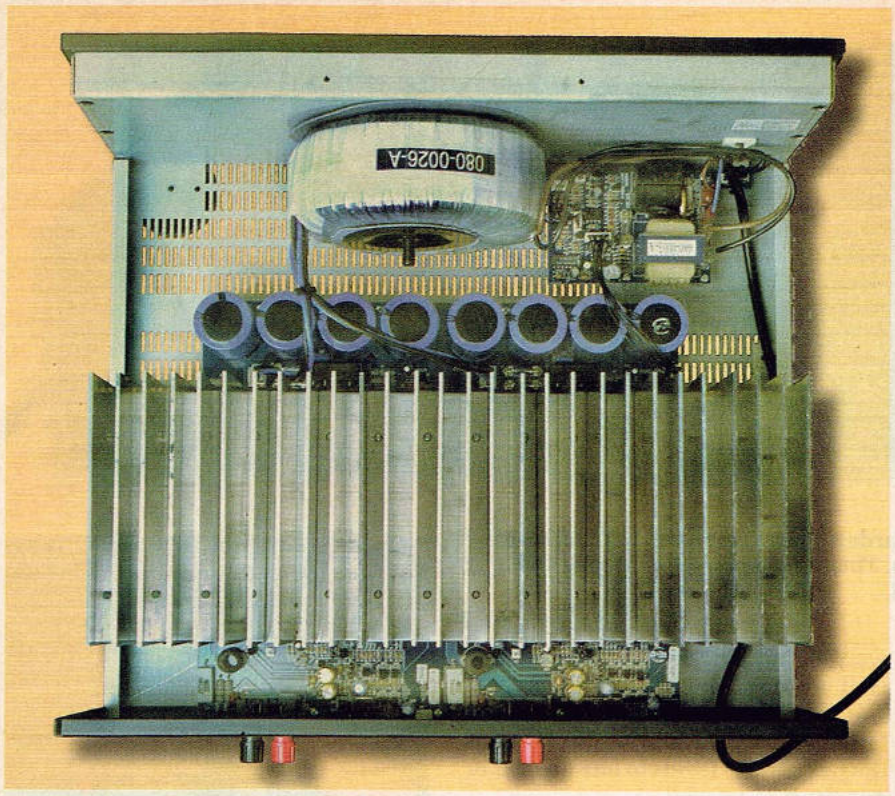
Naturally, in line with other Dolby Pro Logic decoders, the Harman Kardon provides a full range of theatre sound modes (four), music modes (also four), plus stereo, mono and mono plus. The latter is a mono mode for Dolby Digital. We don't know why you'd want it, but there it is. When using a Dolby Digital source, there is even a "late night" mode which while maintaining full signal bandwidth, reduces the peak audio levels to one quarter or one third of normal.

We interpret this as a reduction in peak levels of 10 to 12dB, a significant decrease. Harman Kardon refer to this as the "good neighbour" since it mutes loud audio transients such as explosions or musical crescendos.

Just to show how complex the Processor/Tuner is, the owner's instruction manual has no less than 65 pages (all English). This impression of complexity is reinforced when the top cover of the case is removed, revealing a myriad of integrated circuits and LSIs dotted over a number of large PC boards. Even the power supply is quite complex, employing two E-I trans-

The remote control has lots of buttons but is fairly self-explanatory in use.

The Harman Kardon Signature Series 1.5 stereo amplifier is well finished, with an absolute minimum of ornamentation.



TOP: inside the Harman Kardon amplifier, showing the large toroidal power transformer and the heatsink fabricated from sheet aluminium. The rear panel view is shown above.

formers with copper straps around them to reduce hum radiation.

Stereo power amplifier

By contrast with the Processor/Tuner unit, the Signature Series 1.5 power amplifier is simplicity itself. But it is large, and heavy. It measures 438 x 191 x 387mm and weighs 21.4kg. Apart from the on/off switch and a power indicator, the front panel is devoid of any ornamentation. The back panel is pretty sparse too, with just two pairs of loudspeaker terminals, two RCA input sockets and a socket for a trigger control, referred to earlier. There is also a small slide switch to provide bridged operation of both channels.

Sparse it may be, but this is an impressive unit, especially when you remove the top cover. This reveals a large toroidal transformer mounted vertically against the front panel. This may seem unconventional but as we found with our own 100W/channel amplifier published in February 1988, this arrangement gives minimum hum pickup in the two audio channels.

As far as we can tell, the power transformer has separate centre-tapped secondary windings to effectively provide two completely separate power supplies to feed the two power amplifiers. This arrangement maximises channel separation although it does mean that more components are required; ie, an additional bridge rectifier and filter capacitors.

The power amplifier circuitry itself is largely hidden from view by the very large heatsink which occupies most of the chassis. The heatsink is interesting because it is not the usual large aluminium extrusion but has been fabricated from sheet aluminium. The chassis and top cover have been well and truly perforated to provide plenty of ventilation for the heatsink, so that no fan is necessary.

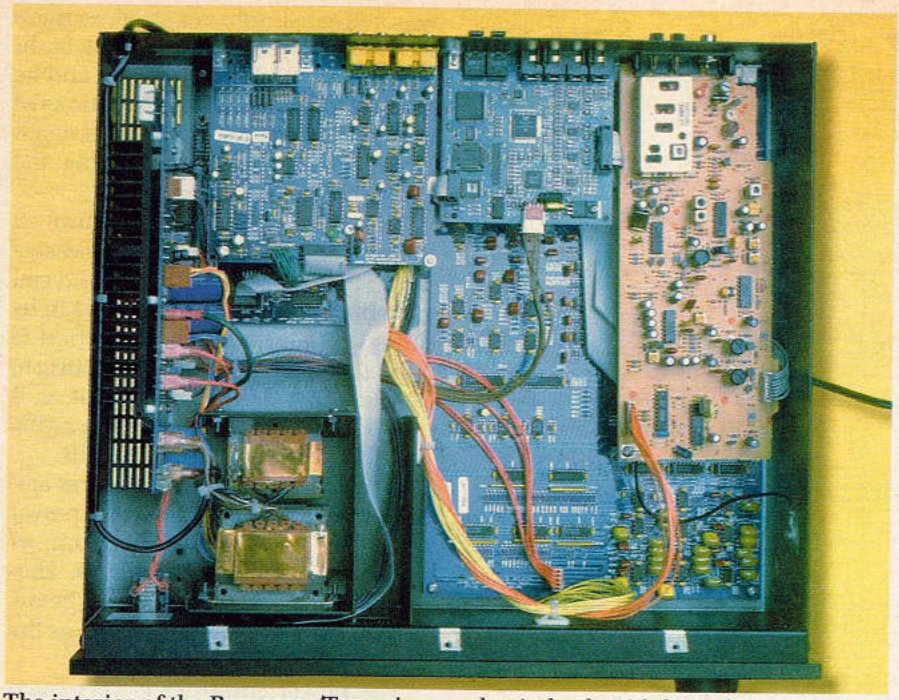
As far as we can tell, the Harman Kardon power amplifier employs bipolar transistors throughout and has separate relay muting for each channel.

As well as the main power transformer, there is a separate smaller transformer and power supply board and this evidently provides the standby function, so that the power amplifier itself can be switched on and off by a trigger signal of between 6V and 12V from the Processor/Tuner unit.

The Harman Kardon amplifier is rated at 200 watts per channel into 8Ω loads and 325 watts per channel into 4Ω, for a rated harmonic distortion of less than .03%. In bridged mode, it will deliver 650 watts into an 8Ω load, again for a rated distortion of less than .03%.

While being delightfully vague about circuit configurations (ie, they tell you nothing), Harman Kardon emphasise that they only use a minimum of negative feedback to achieve their amplifier performance. The implication is that lots of negative feedback is somehow "bad" and the less feedback, the more merit in the design. They state that the negative feedback in the amplifier is less than 25dB.

Naturally, we don't agree with this approach. If using lots of negative feedback achieves high performance, then it is all to the good, as far as we are concerned. Harman Kardon's figure of 25dB probably applies to the overall negative feedback from output to input but in our experience, any amplifier design which performs well and uses little overall negative feed-



The interior of the Processor/Tuner is complex indeed, with lots of ICs, LSI chips and surface mount devices.

back actually uses lots of local negative feedback around each stage. Often this feedback may take the form of emitter degeneration or lag compensation but it is feedback nonetheless.

So while we would not criticise an amplifier with low overall negative feedback just because the designer took that approach, we do think it is doing it the hard way.

The other notable feature of the Harman Kardon amplifier is its very high output current capability and this amplifier is rated at ±130A. Again, while we don't think high current capability is bad, we cannot see why any amplifier of this power rating could ever need to deliver a peak current in excess of 125 amps.

To explain further, a power ampli-

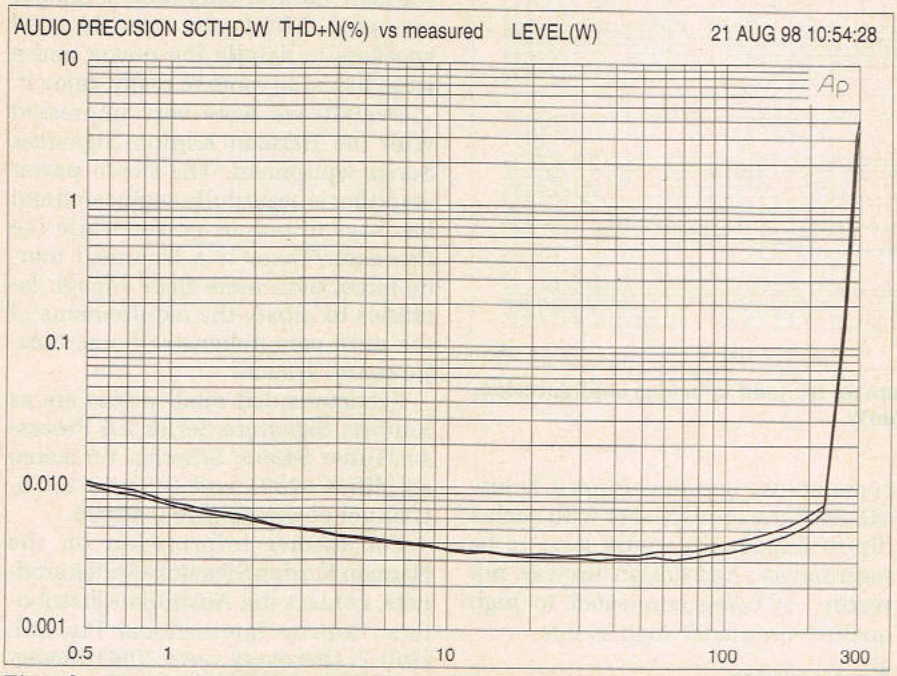


Fig.1: harmonic distortion versus power into 8Ω loads, with both channels driven. Distortion is well below the rating of .03%.

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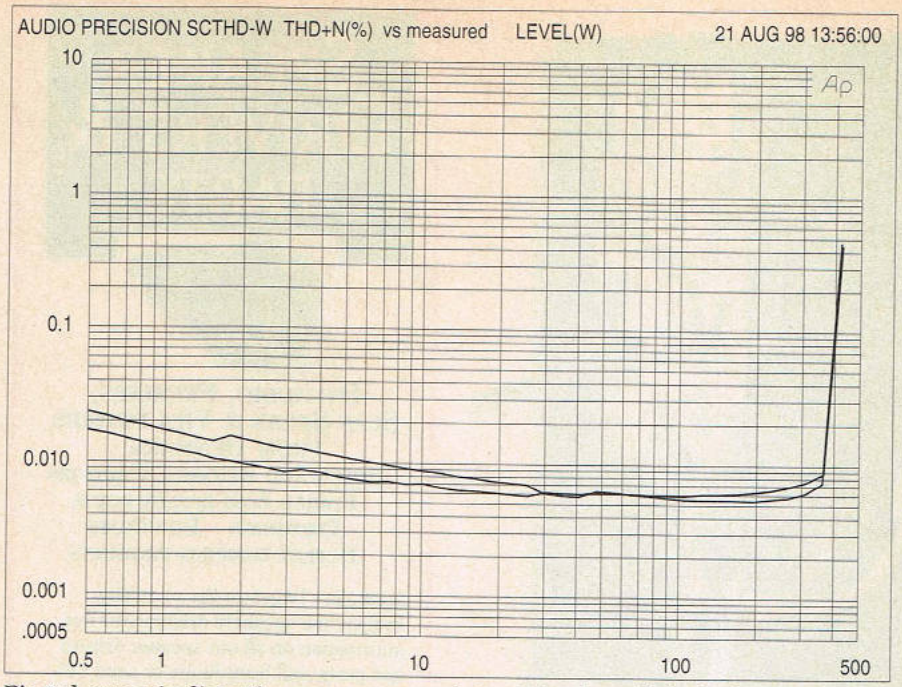

Fig.2: harmonic distortion versus power into 4Ω loads, with both channels driven. Distortion is still well below the rating of .03% while maximum power is more than 360W.

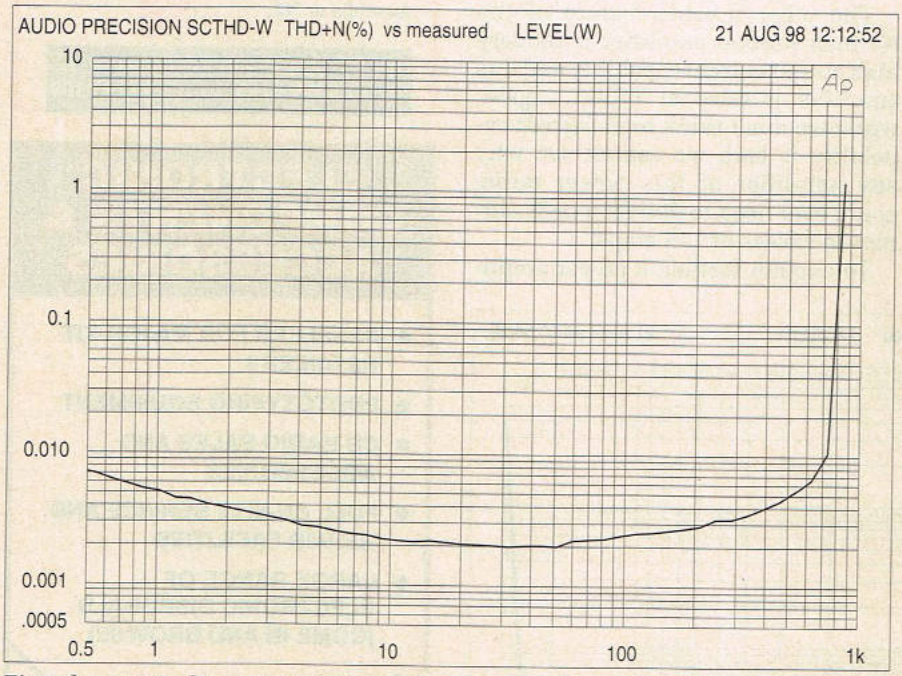

Fig.3: harmonic distortion versus power into an 8Ω load in bridge configuration. Maximum power before clipping is over 700W.

fier rated to deliver 200 watts into an 8Ω load will have a peak output voltage of ±56.6V. In order for it to deliver 125 amps, the load impedance would have to drop to below 0.45Ω or 450 milliohms.

Now we know that some loudspeakers have very nasty dips in their impedance curves but we have never come across one that dipped below 1Ω. And any loudspeaker with such a dip in impedance would have to be regarded as a bad design anyway, not worthy of being connected to high quality equipment such as this.

Test results

Testing this elaborate equipment was neither simple nor quick as there were so many functions to look at. In the end, we had to be realistic and be content to test only a few functions of the Processor/Tuner while being much more comprehensive in testing the stereo power amplifier.

In short, we were able to confirm all the specifications of the Processor/Tuner that we actually tested and can state that it is fairly conservative in its ratings. Total harmonic distortion is quoted as less than .03% from 20Hz to 20kHz and it easily meets that as it does for its frequency response rating of 20Hz to 50kHz within ±0.5dB.

For the Harman Kardon power amplifier, we easily confirmed the power ratings, as the accompanying power/distortion curves demonstrate. Harmonic distortion was typically below .01% which is considerably below the rated figure of .03%.

The power amplifier is very quiet as well, delivering a figure of -116dB (unweighted) with respect to 200W and -120dB A-weighted. Its frequency response is very wide and is only 2dB down at 200kHz.

Listening tests confirm that this is fine equipment indeed but where it really performs is on music that "begs to have the wick turned up" such as full symphony orchestral performances and on pipe organ. This reviewer is a fan of Wurlitzer theatre organs and when playing this material, the Harman Kardon amplifier is simply awesome. Mind you, you do need speakers to handle the power and a large listening room to really enjoy it.

Overall, we were very impressed with the Harman Kardon Signature Series equipment. The stereo power amplifier is beautifully engineered and has bags of output power while the Processor/Tuner is a technical tour-de-force, with more than enough facilities to satisfy the requirements of the most comprehensive home theatre sound system.

Recommended retail prices are as follows: Signature Series 2.0 Processor/Tuner $4395; S/Series 1.5 stereo amplifier $2895 and S/Series 2.1 5-channel power amplifier $2995.

For further information on the Harman Kardon Signature Series products, contact the Australian distributors: Convoy International Pty Ltd, Unit 7, Discovery Cove, 1801 Botany Road, Botany NSW 2019. Phone (02) 9700 0111. **SC**

MAILBAG

Technology disposal to cry about

I'd like to make some observations and comments regarding your editorial in the September 1998 issue. First, as an amateur constructor, designer and would be trainee electronics tech, your notes hit the mark perfectly. I regularly scour the tips in this area looking for items of "junque" that may be either recycled, repaired or experimented upon. You would be flabbergasted at the treasures that surface at more than regular intervals. However, nothing can be got for free these days so a token payment to the salvager who owns the rights to the tips I scour sees me get away with some awesome bargains.

For example, the desk at which I'm sitting ($20) is fully electronically height adjustable, weighs 160kg and cost me less than 5 cents to repair (a roll pin). It cost $2000 new! The 15-inch SVGA monitor ($3) I'm looking at cost the price of 25mm of 0.8mm solder to refix the data input plug to the main board, courtesy of the Queensland Education Department. The 586/100 ($6) that's doing the number crunching cost $100 for a used 210Mb HDD, courtesy of an unnamed national company. I've since added a 32X CD-ROM, 1.2Mb 5.25-inch floppy, sound card, more RAM (from 12Mb to 16Mb), PCI video card and a BJC255SP printer, all new at retail prices.

Oh! I almost forgot the gas strut office chair ($5) repaired with a 20-second burst of the MIG welder. How's that?

What I've just described has taken me some two years to complete and doesn't happen every day. Every other day sees 386, 286 and XT computers, monitors from mono to SVGA, washing machines, stereo components (wow, that's another story!), lawn mowers, whipper snippers, lashings of various parts, reusable timber, glass panes, light fittings, heavy timber doors, telephones, hand and electric tools and small stationary engines (some brand new!) added to the list. I'm not kidding!

Now for the frightening part. How about computers that have become superfluous to company needs for whatever reason(s) that still have (working) hard drives installed, from financial institutions, accountants, hospitals, homeowners, etc. I'm not kidding! How do I know? The hard drives are still full! I wipe 'em and sell 'em but the information on some of them would make your eyes pop!

What can one do with such "ancient technology"? This is not my idea but I thought it was a beauty. I discovered a book by R. A. Penfold (Babani Electronics Books BP272) entitled "Interfacing PCs and Compatibles" that describes in detail the use of 74LS138 decoders and 82 (C)55 PPI (Programmable Peripheral Interface) to interface computers with external I/O for use with relays and data-logging circuits using BASIC programming. My specific use for this is a watering system for my yard, presently switching 24 taps at programmed intervals to water my 6-acre yard.

Another good point is the use of my 586 to do the programming and compiling to an EXE file This is then copied to a boot disk and fired up using the autoexec.bat file right after the computer boots. Once the bugs are ironed out, the 286 I use for the interfacing can use a floppy to boot up – no hard drive or monitor is needed, just a keyboard and video card.

S. Clavan,
Black River, Qld 4818.

Old PCs needed for schools

I write with regard to your editorial in the September 1998 issue of SILICON CHIP. Yes, there is a need and use for 386/486 vintage computers. I am an electronics, systems technology, robotics teacher (secondary) who could use such machines. My primary use would be to run the many programs that work quite happily with Windows 3.1 – programs such as LEGO Control Lab, PC Logo, Intellecta and the Softmark interface project from the last issue of SILICON CHIP, to mention but a few.

My secondary uses would be to teach computer repair and upgrade skills to students. I believe some local schools are already into this activity.

To emphasise the need, this year my school received a donation of 4 x 486 computers, without monitors, mice or keyboards from Alcoa. Setting up the computers with monitors, etc, broke our budget and we may be able to find enough money with P & C help next year to provide software and site licences.

I am at a reasonably well-off secondary school in Perth but there are many other schools not so well off, especially the smaller primary schools (and country schools) who could also put such computers into productive classroom activities.

To your readers, if you have such computers to give away, please contact your local schools.

M. Callaghan,
Maddington, WA.

Old computers are not useless

I found your editorial on old PCs very thought provoking, to the point that I am tempted to put pen to paper – electronically speaking, that is.

In my semi-retirement I have made up many inexpensive computers from leftover parts for friends and those who cannot afford the latest technology (ie, $50 286s) with which they can accomplish almost anything apart from playing fast RAM-hungry games and perhaps running some of the high-end business graphics.

I am amazed that the Education Departments have seen fit to issue Pentiums to our schools when those in the USA are quite content to utilise other departments' outdated models, which in this country are virtually given away to stunned bidders at local auctions! Is Australia really so affluent; can we actually afford it?

Thus, in answer to your editorial, I do not find those unloved machines useless – they are indeed a most useful tool and teaching aid. Dare I suggest that the educators of this country think again before squandering huge sums on machines that really are not necessary in the circumstances?

J. Harding,
Lauderdale, Tas.

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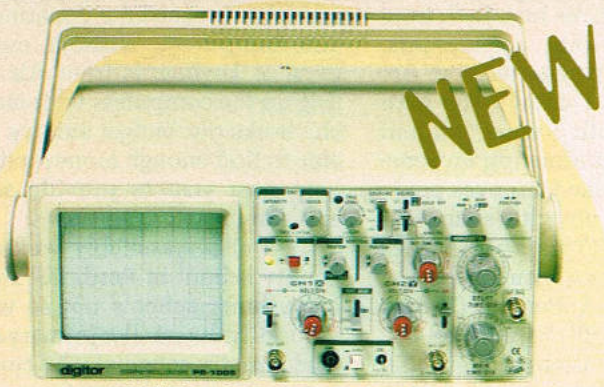
Where do you go for new electronics ideas ?



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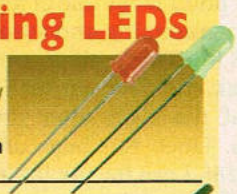

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K 7125

$19.95 EA Dec '98

NEW

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- Can be used with any digital multimeter
- Temperature range governed by probe characteristics
- Range of probe supplied: -4°C to 250°C
- Connects to your digital multimeter via flying leads and banana sockets
- Operates on 1 x AA, 1.5V DC and 1 x 9V DC battery
- Comes with case, front panel label, battery clips PCB and all components

K 7120

SILICON CHIP Dec '98

$39.95

Actual product may differ from image shown

NEW

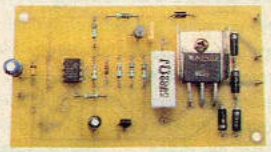
Engine immobiliser Mk II

- Circuit stalls engine when activated
- Connects directly to ignition system
- Kit can be assembled and used independently
- Can also be interfaced with control module (keypad) to be released shortly
- Power supply: 12V DC
- Includes all components, case and PCB

K 4303

$39.95 SILICON CHIP Dec '98

NEW



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- Tester for line-output or 'flyback' transformers and HF wound components
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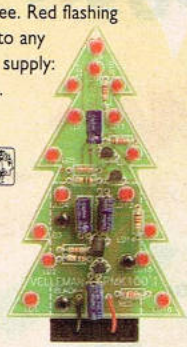

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- 2-way communication
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- Uses 4 x AA batteries or power directly from motorcycle
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K 6021

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$39.95 EA Jul '98

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- With all components, hardware, PCB, case, pre-punched and screened front panel

K 7347

$34.95 EA Aug '98

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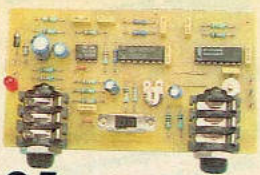
- Popular guitar effect is controlled by a foot pedal *(not included)*
- Resulting sound produces suddenly increasing/decreasing volume
- Includes PCB stakes, PCB, components and PCB mounted 6.75mm sockets.

K 5620



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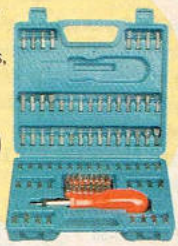

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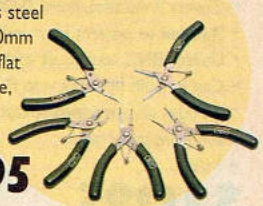

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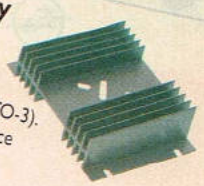

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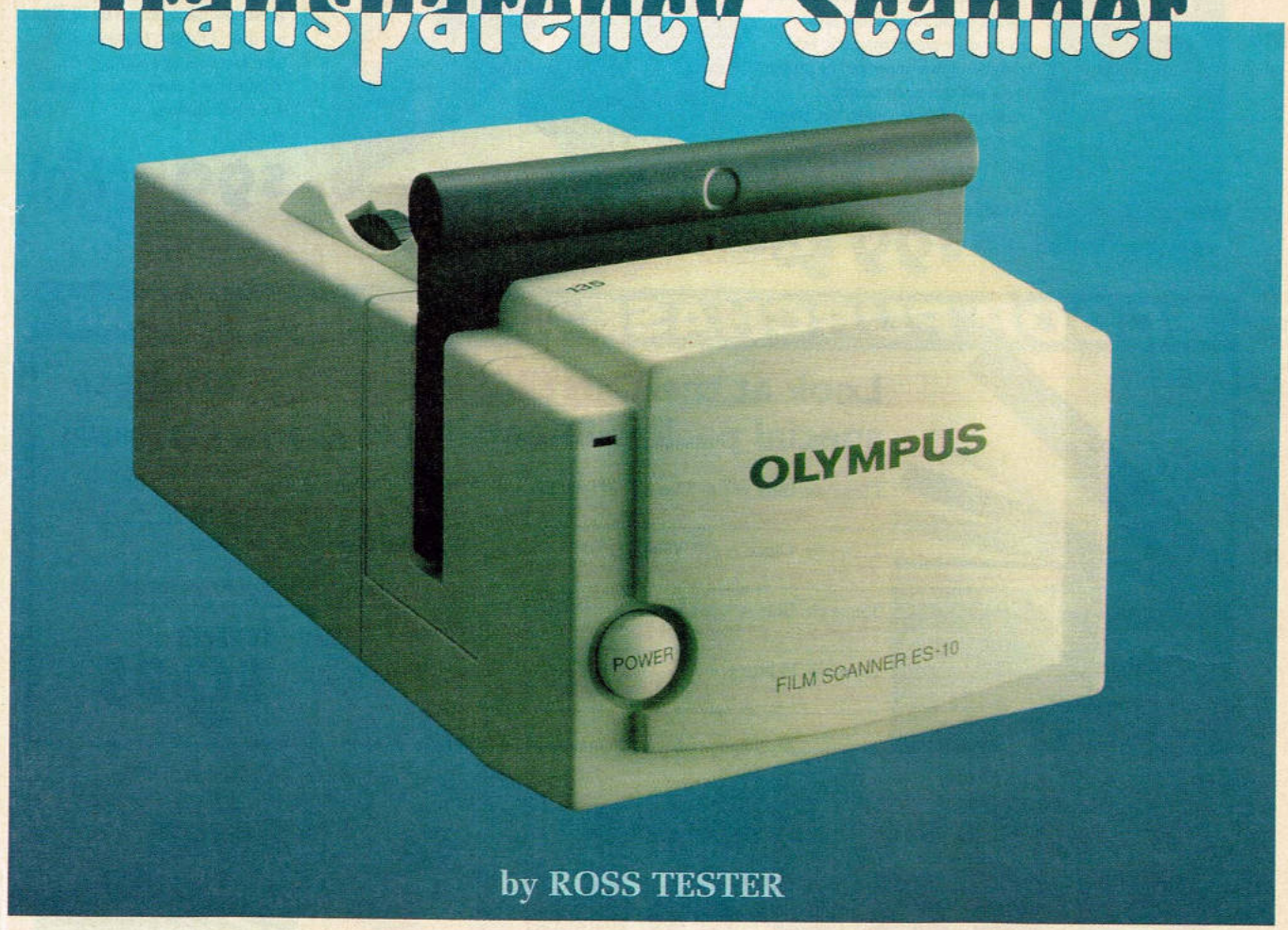

by ROSS TESTER

Compared to just a few years ago, computers have made life almost blissful for anyone wanting to get into print.

Consider the printed word, for example: thirty years ago, most type was set in molten metal. Then along came photo-typesetting where paper "galleys" or strips of type were cut and pasted onto a page. The natural progression was to computerised imagesetters where whole pages of type could be assembled on screen and output as a finished page.

But what about photographs?

Until fairly recently, photographs had to be treated as a separate item to be manually inserted into appropriate-size spaces left in the page. Indeed, some magazines are still produced this way.

The problem was, and still is, that photographs, which are also known as "continuous tone", contain a virtually infinite number of shades of grey between white and black. Printing presses, though, have only one shade of ink: black. They cannot simply print shades of grey.

To print a photograph using black ink, the photo first has to be converted into a "half tone" where those shades of grey are replaced by varying sized dots, the size in proportion to the den-

sity of the shade. Light areas have very tiny dots, darker areas larger dots. In solid black areas, the dots virtually merge.

In a way, it is an optical illusion: viewed from far enough away, the eyes converge the halftone's dots into a fairly faithful reproduction of the original photo.

Converting a continuous tone to a half tone normally requires special equipment, techniques and a great deal of skill on the part of the operator.

Colour photographs open a whole new can of worms because colour printing is primarily based on printing four colours of ink – cyan (a light blue), magenta, yellow and black. The original photograph has itself to be photographed four times with colour filters to pick out these four colours and at the same time convert each of them into dots of various sizes, as for a black & white image.

And to avoid strange patterns in the final print, each of the four screened images has to be photographed at a different angle to the others and the four images have to be printed, one on top of the other, with a very high degree of accuracy.

The Kodak Photo CD. In this "pro" version, approximately 100 images can be stored on a CD-ROM. When the discs are scanned, an index card is printed which contains a thumbnail of each image on the disc. A full "pro" disc costs around $750 - $1000. The pro version can also handle larger format transparencies, albeit at significantly increased cost.

When printed, the eyes not only converge all the dots, but combine the four colours of ink so that a reproduction of the original photograph is seen. Again, the quality of the printed photograph depends to a very high degree on the skill of the people involved, all along the chain.

Then along came computers

It took some time before computers had enough "grunt" to do the job and early software was somewhat primitive by today's standards. But at last, type and photographs could all be handled together on the screen with power hitherto only dreamed about – desktop publishing was born.

To go with the more powerful computers, desktop scanners started appearing. These early scanners handled only black and white photographs;

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INFRA-RED SENSOR
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Similar to mail couriers used in large organisations, follows a designed course using an infra-red emitter and light sensing circuit. Draw you own track and it will follow it.
INFRA-RED SENSOR
Normal selling price $116.95

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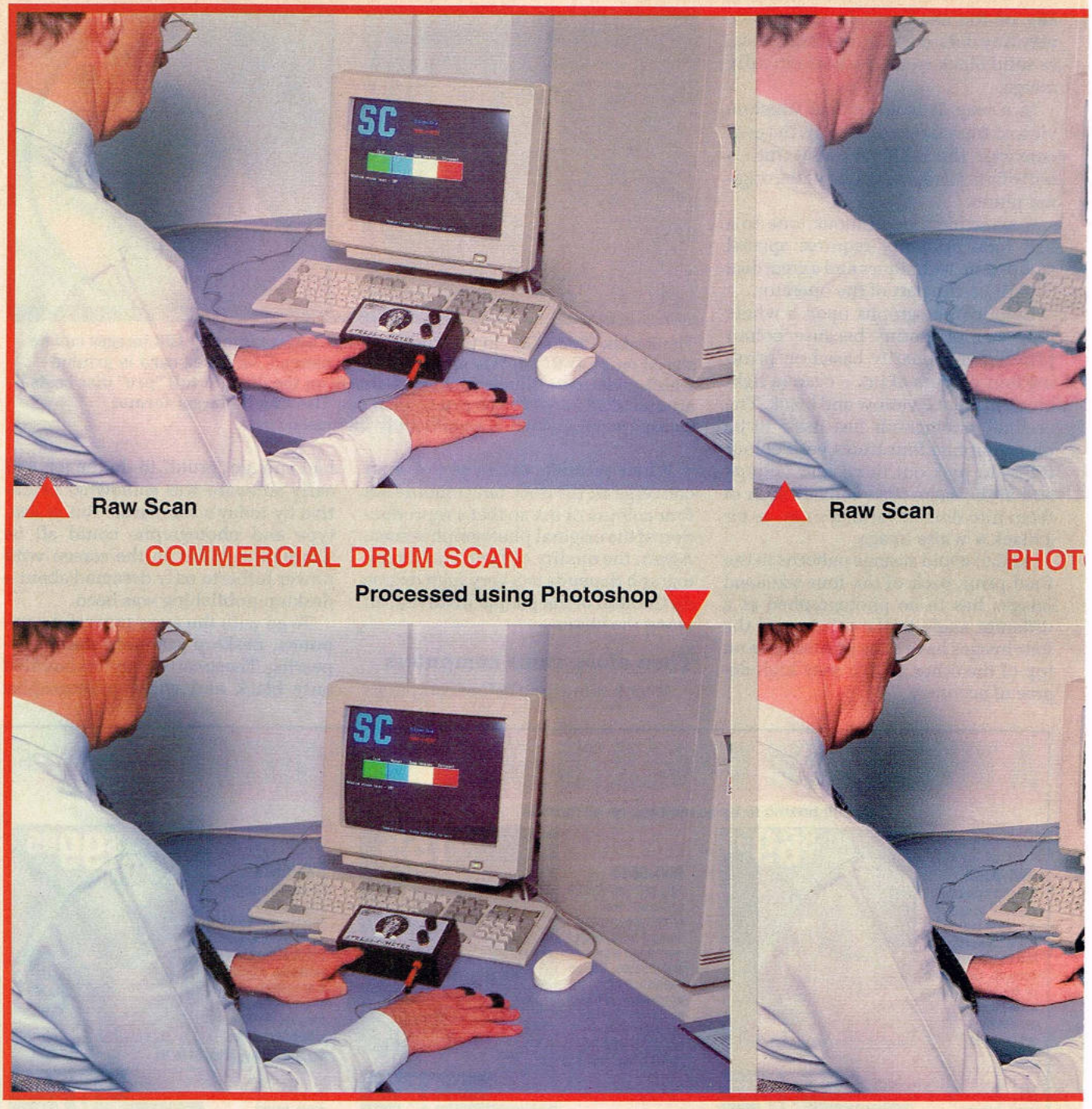


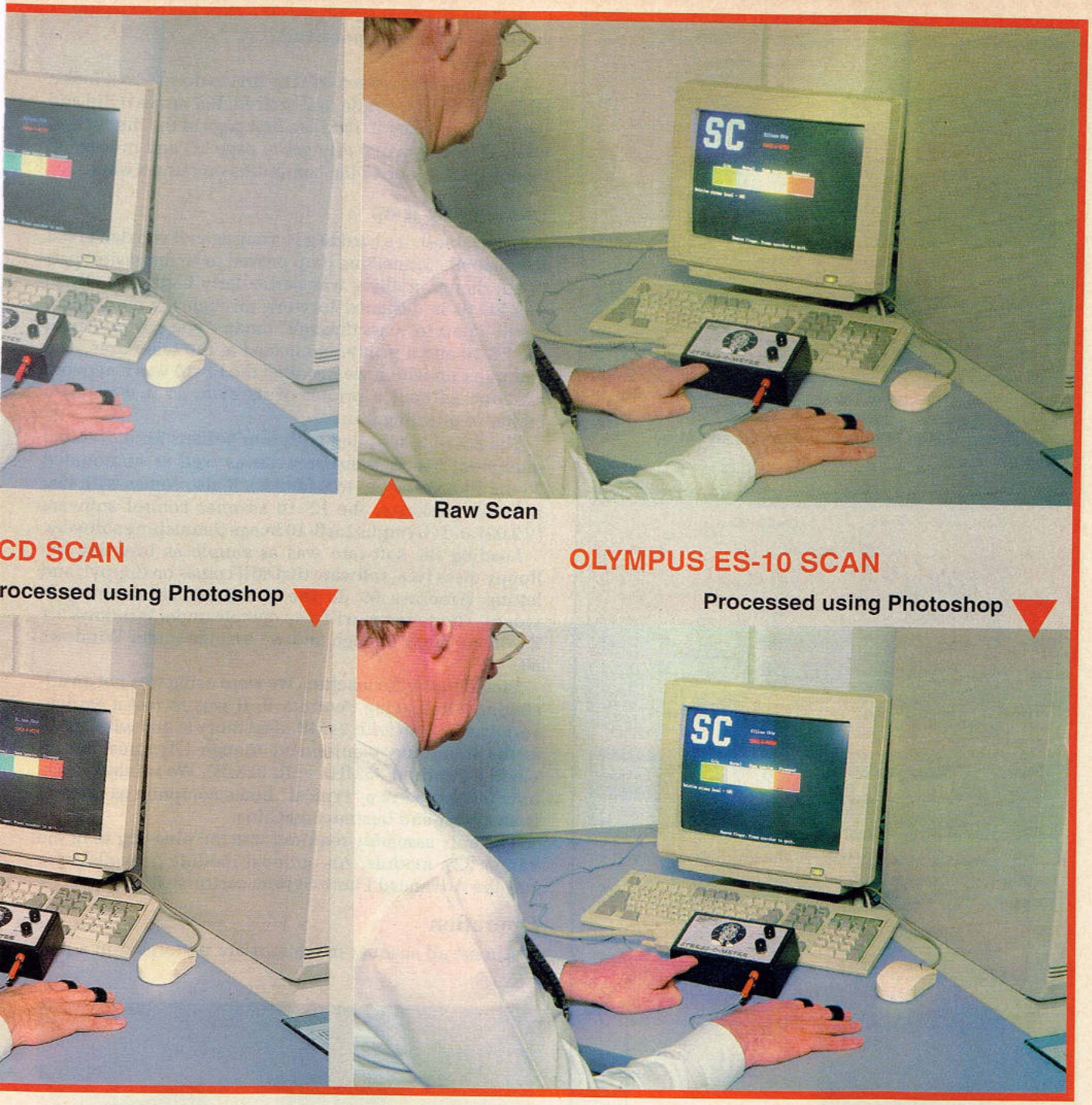
today's models handle glorious, living colour.

Sure, commercial scanners had been around for a long time – in fact, that's how most halftones, especially colour, have been processed for years. But what the desktop scanner did was bring this operation down to desktop level and, more importantly, at an affordable price.

One stumbling block, though, has been in handling transparencies (or slides). Many desktop scanners had transparency options but the quality has, for the most part, always been significantly lower than that of a commercial scan.

There have been other options – some viable, some not. One option which we at SILICON CHIP have used with great success is the Photo CD. This is a system introduced a few years ago by Kodak and involves having transparencies scanned by a specialist scanner into a proprietary format which greatly reduces the file size with very little degradation, The image files are then stored on a CD-ROM. While the system works well, the problem is time – having to send the transparencies away, have them scanned, get them back, then process them.

Incidentally, a Photo CD service is available through all Kodak Image Centres and most dealers. While commercial quality scans (ie, for commercial reproduction) are not cheap Kodak, and others, offer a quite low cost scanning service to the home user.



If you have a number of transparencies (positive or negative) and want to be able to access them via your personal computer, this is a most attractive proposition. Enquire at any Kodak photo processor or dealer.

Other people have tried using some of the newer digital cameras as slide scanners. While some manufacturers say this is practical, you've probably seen the often awful results obtained by the current generation of digital cameras in other magazines!

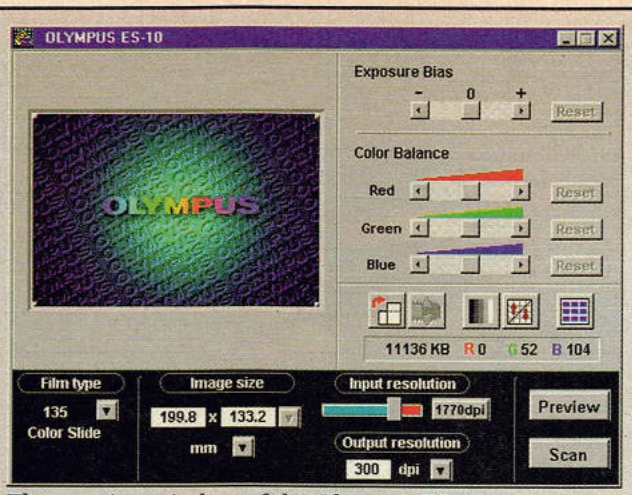
(Unless you spend a lot of money, the results show most digital cameras are not that marvellous when it comes to taking ordinary photos, either.)

Digital cameras will get there . . . but they're not there yet.

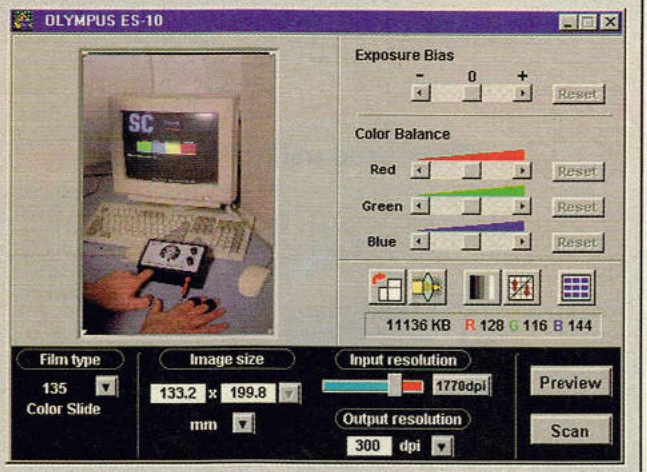
So are there any other options?

For some time we've been looking at desktop film scanners. Unfortunately, our expectations based on specifications or salesmen's hype have never quite been equalled by the results. Either the performance was way below par . . . or the performance was acceptable but the price tag certainly wasn't. We were resigned to continuing the Photo CD route.

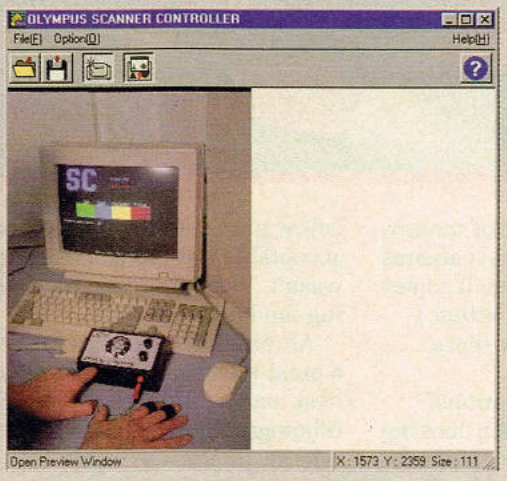
All of which made us look twice at a press release which passed over our desk earlier this year from R Gunz (Photographic) Pty Ltd announcing the release of the Olympus ES-10 Film Scanner. It promised "outstanding image quality" (don't they all?) but perhaps more importantly, a retail price of around $895.



The opening window of the Olympus ES-10 control software. Most parameters can be set on-screen before the preview button is selected and after about 10 seconds . . .



. . . the preview scan appears in the window allowing further adjustments such as colour balance, density, cropping, etc, The scan button is then selected . . .



. . . and after quite a delay (up to 5 minutes) the final scan appears. This is then "tweaked" in a photo-processing program.

And the final paragraph was the clincher: "to arrange a sample unit for evaluation call . . ."

We called.

Unfortunately, we weren't the first to do so – so it took a while before the sample unit arrived. But arrive it did and we duly unpacked it, read the first page of the instruction manual (does anyone *ever* get to page 2?) and proceeded toconnect it to one of the computers on our network.

Connecting it up

To be honest, it's hard to go wrong even if you don't read the manual. Connecting it up proved to be the easiest part of all, though nothing was particularly hard. The Olympus ES-10 is designed to work through the computer's parallel port in "pass through" mode – you can have both the ES-10 and a printer connected at the same time. The computer on which we installed the ES-10 was a network machine without a printer of its own, so it was just a matter of plugging it in.

The ES-10 is supplied with film holders for individual (mounted) 35mm transparencies as well as unmounted 35mm film strips (up to 6 frames). It also comes with two software packages, the ES-10 scanner control software (V2.02) and Olympus LAB-10 Image Retouching software.

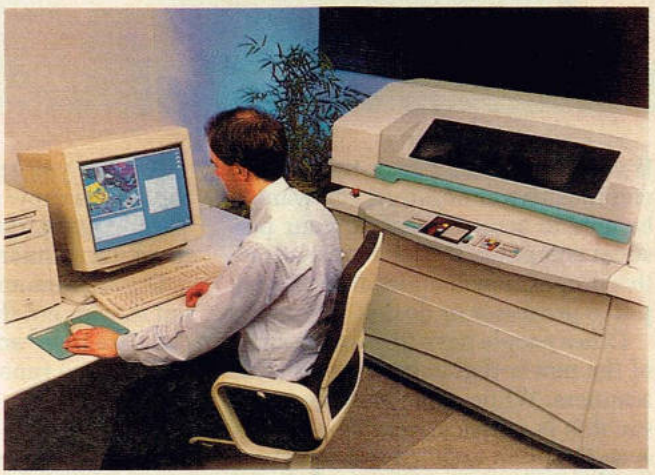
Loading the software was as simple as inserting the floppy discs (yes, software that still comes on floppy!) and letting Windows 95 do the rest (instructions are provided). The software will also operate under Windows 3.1 if you are crazy enough and we assume under Windows 98.

Incidentally, the machine we were using was not an all-singing, all-dancing Pentium II. It was in fact a garden-variety 486 2/66 with 24MB of memory (a 486 with 16MB is the minimum requirement though Olympus recommend a Pentium 75MHz with 32MB). We wanted to see how it behaved in a "typical" home computer as distinct from a high-end business machine.

The only assembly required was the plugging in of the 35mm film module. An optional module is available to suit the Advanced Photo System cartridge film.

Operation

Almost all scanner operations are performed in a pre-



Not quite desktop size . . . this is one of the drum scanners at SILICON CHIP's printers – Macquarie Print in Dubbo, NSW.

view window, which opens when you run the ES-10 software.

This window allows you to select various parameters:

- the film type (slides, various brands of colour or B&W negatives)
- the image size you want (pixels is the default but this can be changed to in, mm or cm)
- the input resolution (up to 1770 dpi) and the output resolution
- a number of slider controls which can adjust the colour balance (red, blue and green, plus or minus)
- the exposure bias (brightness plus or minus)
- image rotation (90° per time)
- focus (interacts with focus control on scanner unit)
- gamma curve compensation
- black & white conversion

There is also a "preview" button and a "scan" button:. The preview button is selected first which gives a quick image in the viewfinder, allowing cropping and other parameters above to be set. When all is ready, selecting the "scan" button starts the scan proper.

The main scan takes some time, depending on the input resolution selected, the image size and amount of cropping. Working on the theory that the highest possible resolution would give the best possible image to work with, we elected to scan our slides at 1770dpi (which is a default anyway).

Most slides took in the region of five minutes to scan at maximum resolution, as per the specifications. Olympus also claim an 80 second scan for a 1000 x 1000 pixel resolution.

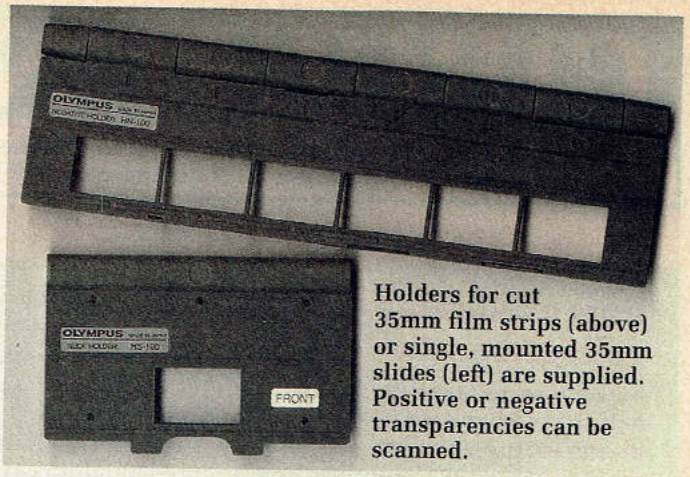
We also took the opportunity to scan several colour negatives – the type you get when you shoot a roll of colour film – and some b&w negatives. With many of today's quality inkjet printers you can get virtual photographic quality output.

Using this scanner, would the average person be able to "print their own photos", either black & white or colour, from those negatives gathering dust in the bottom drawer, ?

Saving The Scans

One disappointment we found was that scans only save in bitmap (.BMP) format which has always been our least-preferred option. Most other scanners will allow you to choose the format.

By choice, we work in either .TIF (tagged image file format) for b&w, or .EPS (encapsulated Postscript) for colour because these are what the company which prints SILICON CHIP requires. Still, it's only a small point because we were going to process all of our scans in Adobe Photoshop – and this can save in any format.



Holders for cut 35mm film strips (above) or single, mounted 35mm slides (left) are supplied. Positive or negative transparencies can be scanned.

Why Photoshop and not Olympus's own image retouching software? Simple: we're use Photoshop every day in the production of "SILICON CHIP" and we know its capabilities.

We didn't want to introduce another unknown into the equation, perhaps comparing apples and oranges.

Scan quality

So how did the Olympus scans shape up? You be the judge.

We have selected the same transparency and scanned it three ways. First of all, we had our magazine printers do a commercial quality scan on their $60,000 rotary drum scanner. Second, we had the slide scanned and put onto CD-ROM. And third, we scanned the slide at maximum resolution with the Olympus ES-10.

The first row of photos shows the scans as they appeared directly from the various processes (where necessary converted to CMYK EPS format only). Now you can see why raw scans almost always need some work!

The second row of photos shows the same scans after electronic processing using Adobe Photoshop, as we do with all of our photos.

Only a small amount of colour correction has been done, though: normally we would correct the scan to match the slide.

Yes, there are differences between the three, which we would expect. The Olympus scans are not as good as the Photo CD or drum scans. But the Photo CD Scanner is worth about $20,000; the drum scanner much more. For a sub-$1000 scanner, we don't think they are too bad.

Admittedly, we're only reproducing these photographs at 125 x 83mm where in fact all can theoretically be taken to A4 (or full page) size. In fact, the drum scan can go much larger – even the Photo CD scan can, with care, be taken to A3 size. When you think about it, that's a massive enlargement over the original size (35mm slide 24 x 35mm, A3 297 x 420mm) and "people who know" will tell you that you should never enlarge a 35mm above A4 size. Well, we can and do!

Of course, the average home or even small business user will seldom want or need to enlarge to this size so the half page photos give a legitimate guide to what you can expect.

The other thing to remember, of course, is that resolution is very much a function of the output device – if you're scanning pictures for the Internet, for example, you cannot afford to have high resolution because they take too long to load.

(Internet photos are generally scanned at 72dpi or dots per inch but even then are saved with a lot of compression to keep the size as small as possible).

To sum up, we're pretty impressed by the Olympus ES-10 scanner, especially at the price. It obviously has limitations but it does a more-than-acceptable job. And the question we asked before about negatives was certainly answered in the positive (do you like that metaphor?).

Now, boss, can I have one? **SC**

The Olympus Film Scanner ES-10 is available from many photographic outlets and computer specialists. Trade Enquiries to R Gunz (Photographic) Pty Ltd, 26-34 Dunning Ave, Rosebery NSW 2018. Tel (02) 9935 6600, Fax (02) 9935 6622

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

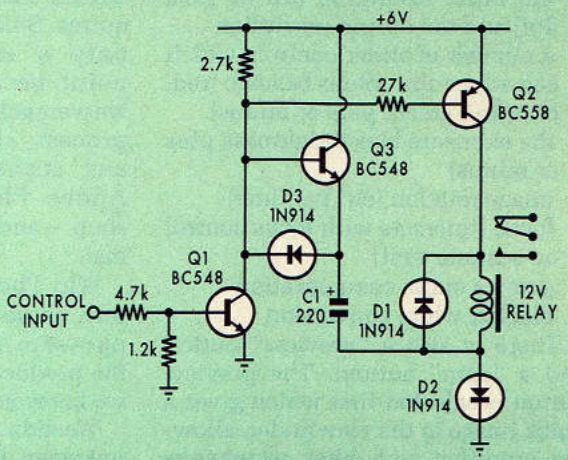
Improved relay voltage booster

The idea of operating a relay at half its rated voltage is sound but the circuit presented on page 26 of the September 1998 issue does have a drawback which could preclude its use in some applications.

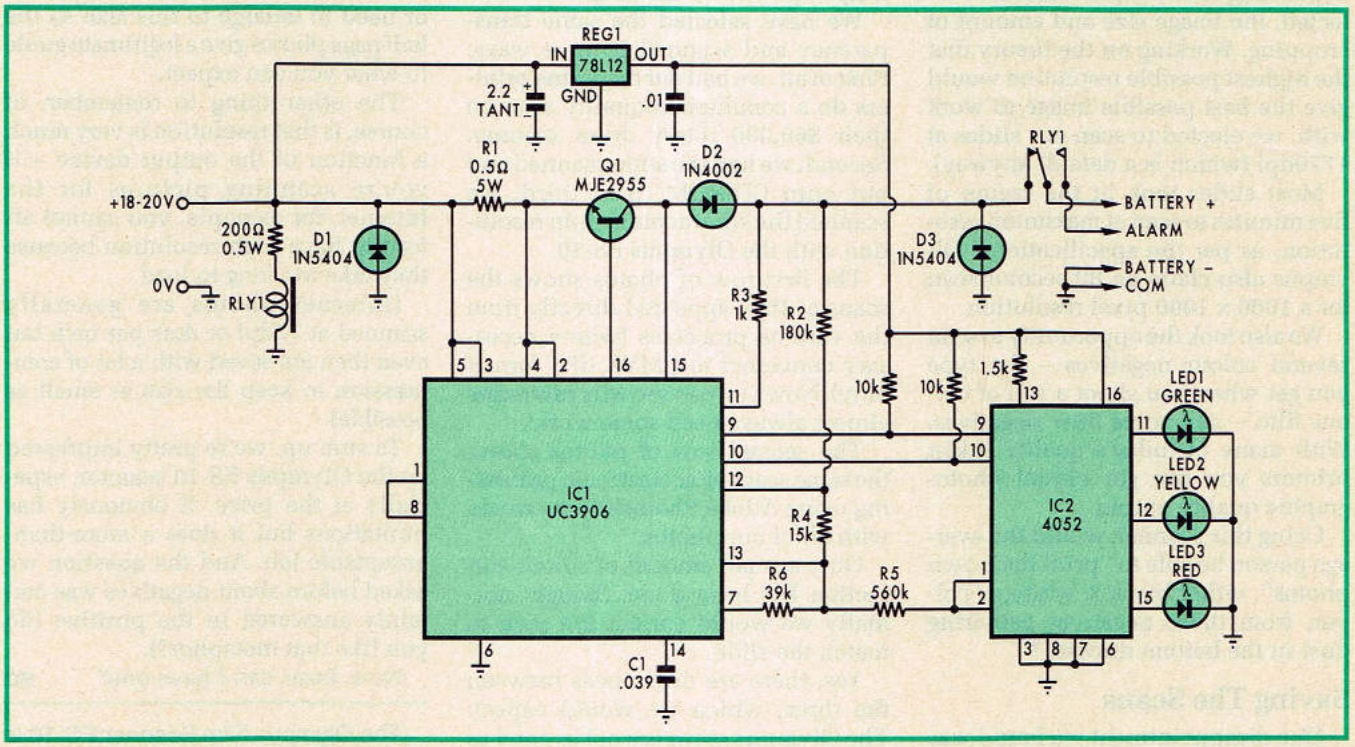
Because the circuit relies on the charging and discharging of a 220µF capacitor, the relay may remain energised for as long as one second after the fall of the control input. Furthermore, if the control input returns high before the capacitor has fully recharged, the stored energy may be insufficient to pull in the relay. This is all the more probable because the voltage drop across diode D2 limits the maximum available voltage to about 10.8V.

The deficiency can be cured by adding a third transistor (Q3) and diode (D3) as shown in this amended circuit. Q3 and D3 isolate Q2 from the recharge current of C1, ensuring that the relay drive reacts immediately to the fall of the control input.

Q3 also provides a fast recharge path for C1, so charging is completed within the mechanical response time of the relay.



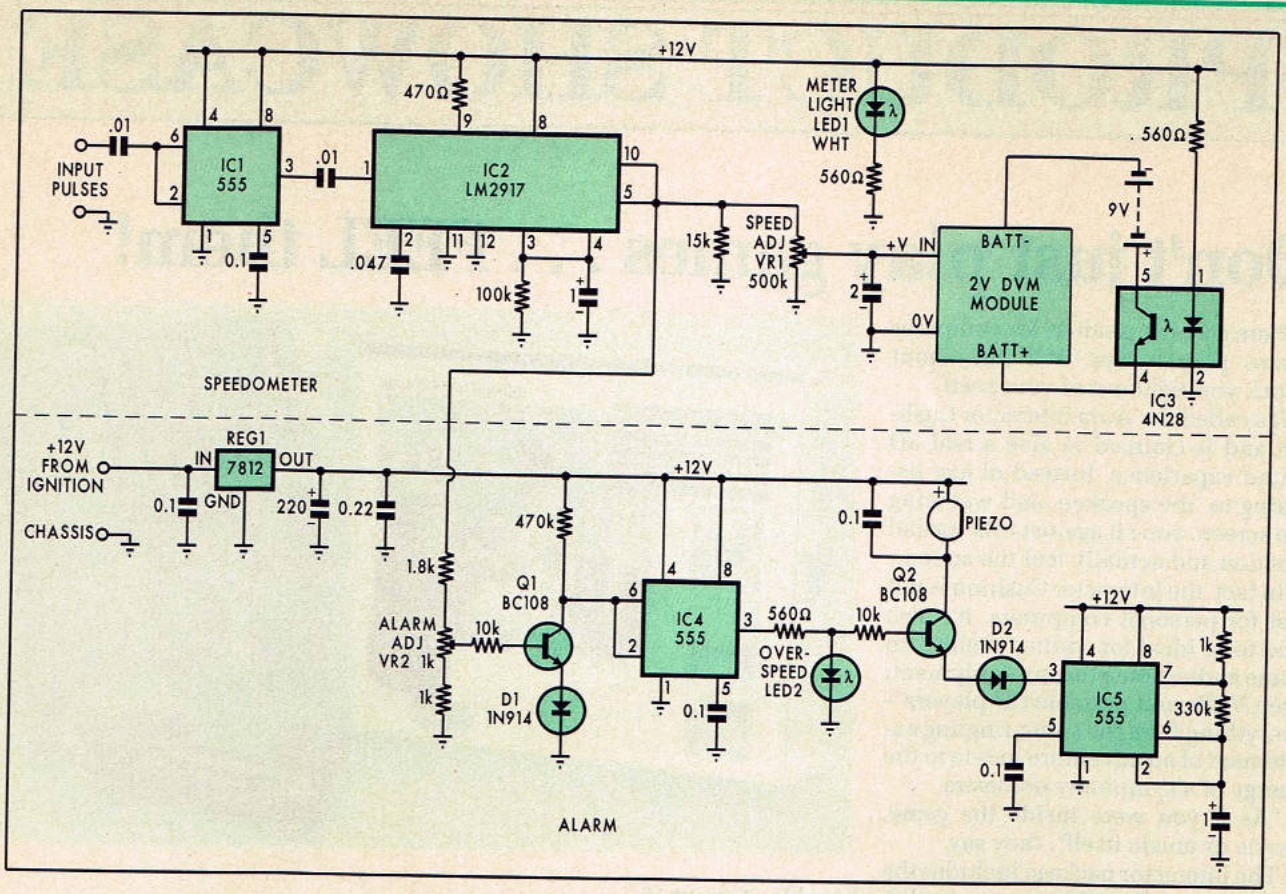
A. Ellis, Porirua, NZ. ($25)



LED indication for 12V SLA charger

These modifications provide a visual indication of the charging states for the 12V SLA charger published in the July 1989 issue of SILICON CHIP. The three charging states are indicated by three LEDs and these are selected by IC2, a 4052 dual 4-channel analog multiplexer/demultiplexer which is used as a 2-pole 3-position switch.

IC2 requires a binary input to pins 9 and 10 and this input is obtained from



Speed alarm & digital speedometer

This circuit provides a digital speedometer plus an overspeed control and alarm and the prototype was installed in a 1990 Celica. This model already has an electronic speedo and its sensor pulses are used as the input to this circuit.

The digital speedo circuit uses an LM2917 frequency/voltage converter (IC2) which provides a DC voltage output to a digital panel meter (Altronics Cat. Q-0560) and this is set to its 2V range with the decimal point disabled and the last digit blanked out with black tape. A multiturn trimpot is used to adjust the voltage at the DVM to 1V when the vehicle speed is 100km/h. The timing components for the LM2917 were chosen to suit the Celica speedo pulses which have a frequency of 75Hz at 100km/h. IC1, a 555 timer, is simply used as a comparator to square up the input pulses before they are fed to IC2.

The digital panel meter requires a separate 9V supply and this is connected via optoisolator IC3 which is enabled when the system is switched on.

IC4, another 555 timer, is also used as a comparator to provide the overspeed alarm. IC4 monitors the collector of Q1 which is biased from trimpot VR2, which is connected to the output of IC2. When the collector of Q1 goes below +4V, pin 3 of IC4 goes high to turn on LED2 and transistor Q2 which drives a piezo alarm.

IC5, a further 555 timer, is connected as a conventional oscillator to modulate Q2 and the piezo alarm.

In practice, it is only necessary to set the vehicle to the required speed, then adjust trimpot VR2 until the alarm operates.

K. McCarroll,
Glendalough, WA. (40)

pins 9 and 10 of IC1, the UC3906 charger controller. A power fail relay has also been added and this disconnects the battery from the charger in the event of a power failure and connects it to an alarm output terminal.

The modification to the original circuit consists of cutting the track between pin 10 of IC1 and resistor R5, thus freeing pin 10 for connection to IC2. Pin 9 of IC1 is connected to pin 9 of IC2, while pin 10 of IC1 goes to pin 10 of IC2. The end of R5 that previously connected to pin 10 of IC1 now connects to pins 1 and 2 of IC2. R5 is now switched in and out of circuit by IC2.

As the input voltage can be anywhere between about 18V and 20V, a 78L12 regulator, IC3, has been used to provide the 12V rail for IC2 and its circuits.

The power fail relay coil is connected across the input supply to the charger, in series with a 200Ω resistor.

R. Sewell,
Annandale, NSW. ($30)

PRODUCT SHOWCASE

Don't just play games . . . FEEL them!

Here's a new product for computer games players that will just about knock you right out of your seat!

It's called the Aura Interactor Cushion and is claimed to give a real 3D sound experience. Instead of just listening to the speakers and watching the screen, you sit against this special cushion and actually feel the action.

In fact, the Interactor Cushion is not just for personal computers. It's also said to be ideal for adding "feeling" to home audio/home theatre equipment; even VCRs and portable CD players – everything from the spine-tingling excitement of an adventure movie to the energy of a symphony orchestra.

"As if you were inside the game, movie or music itself", they say.

The Interactor package includes the cushion, an adjustable power amplifier capable of about 15 watts, a 240V power adaptor and all necessary connecting cables. It also comes with a detailed instruction manual along with a "quick start" card showing the connections for the 99% of people who don't read manuals!

The system is essentially a sub-woofer system which has transducers instead of speakers. These transducers couple the bass signal into the lower back, which is what you "feel".

There is a some audio output from the cushion but this is somewhat muffled, especially when used in a lounge chair. The existing system speakers or headphones would still be required, especially for "serious" listening. Fortunately, a 3.5mm "Y" adaptor is included in the package.

The system is designed to operate from the "line out" sockets on most audio equipment or from the headphone socket on a portable stereo. It would appear that a fair amount of drive is needed as we found both the "volume" control on the portable stereo and the "power" control on the Interactor amplifier had to be at maximum to gain any useful action from the cushion. We didn't have the opportunity to try the system with a line level signal.

The Aura Interactor comes from Jaycar Electronics stores and is in fact part of a surplus stock purchase. For this reason the price is a very attractive $79.95 – according to Jaycar's Managing Director, Gary Johnston, the normal retail price should be well over $200.

Jaycar also sell some of the components for the system, including the power supply which could be very handy for hobbyists with a 23V, 1.25A AC centre-tapped output – almost perfect for making a ±12 volt DC supply. Enquiries to Jaycar Electronics stores or head office at 8-10 Leeds St, Rhodes NSW 2138. Tel (02) 9743 5222, Fax (02) 9743 2066.

Inverters what are they?

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Robotics kits to build

Looking for something different for a child this Christmas? How about a robot? Or, more specifically, a build-it-yourself robot kit? Not only will they learn a lot about robots and robotics as they build the kit, they'll also have a lot of fun with it when it's finished.

World of Robotics, of Belmont (Vic) has introduced a range of robotics kits suitable for all ages. While there are several beginner and intermediate kits (which are basically pre-assemblies), of most interest to SILICON CHIP readers would be the "advanced experience" kits which require the constructor to put the kit together from scratch – including soldering components onto PC boards.

We had the opportunity to look at a couple of the advanced kits and were impressed by the quality of components and especially the presentation. Australia has seen a number of kit ranges introduced from overseas and, to be frank, they have not always passed muster.

Our first reaction on looking at the instructions on these kits was that they reminded us of the presentation of the old "Heathkit" range. Those old enough to remember Heathkit would no doubt also remember that they set the standard by which all kits, past and present, are judged. It's no faint praise then to put the Robotic kits in a similar class. It is perhaps not surprising to find that they, like Heathkit, come from USA.

One kit we looked at closely, the WAO II, has a detailed, step-by-step instruction manual running to 64 pages. Illustrations are very well done – and there's even a section on how to solder for beginners.

What's more, the book is full of testing tips plus troubleshooting sections for when something doesn't work the way it is supposed to.

A limited range of tools is required to put it together – cutters, pliers, soldering iron and a screwdriver or two will just about get you through the process.

So what is the WAO II? It is a programmable, intelligent robot with a 4-bit microcomputer controlling its actions. Through 26 keys you can input the motion program and the WAOII will obey those instructions. It is battery operated, separate batteries being used to power the motors and computer. Communication with a personal computer is also possible through an optional interface card.

Sure, as a robot it's pretty basic. But then most robots are very basic devices, designed to perform a limited number of tasks with precision and repeatability. The likelihood of the speaking, human-type robot of Hollywood movie fame is still quite a way off.

But real robots such as the WAOII are here now and will be fascinating for any child with an enquiring mind (recommended age 12 and up, given the soldering and construction required). WAOII is priced at $155 (other kits available from $39.95), from World of Robotics, 110 Mt Pleasant Rd, Belmont, Vic 3216. Tel (03) 5241 9481; fax (03) 5241 9089 e-mail frances@mail.austasia.net

First quad speed DVD-ROM drives

Hitachi Australia has started shipping a DVD-ROM drive with four times normal speed operation.

The GD-2500 drive has a transfer rate of 5.52MB/s and gives a storage capacity of 8.5GB (4.7GB per side), or seven times the capacity of current CD-ROMs. This is enough space to store a 135 minute MPEG-2 encoded film or video, with room to spare for multiple soundtracks and/or subtitles.

The drives are fully compatible with existing CD-ROM formats, including CD-R and CD-RW. DVD-R discs are also compatible.

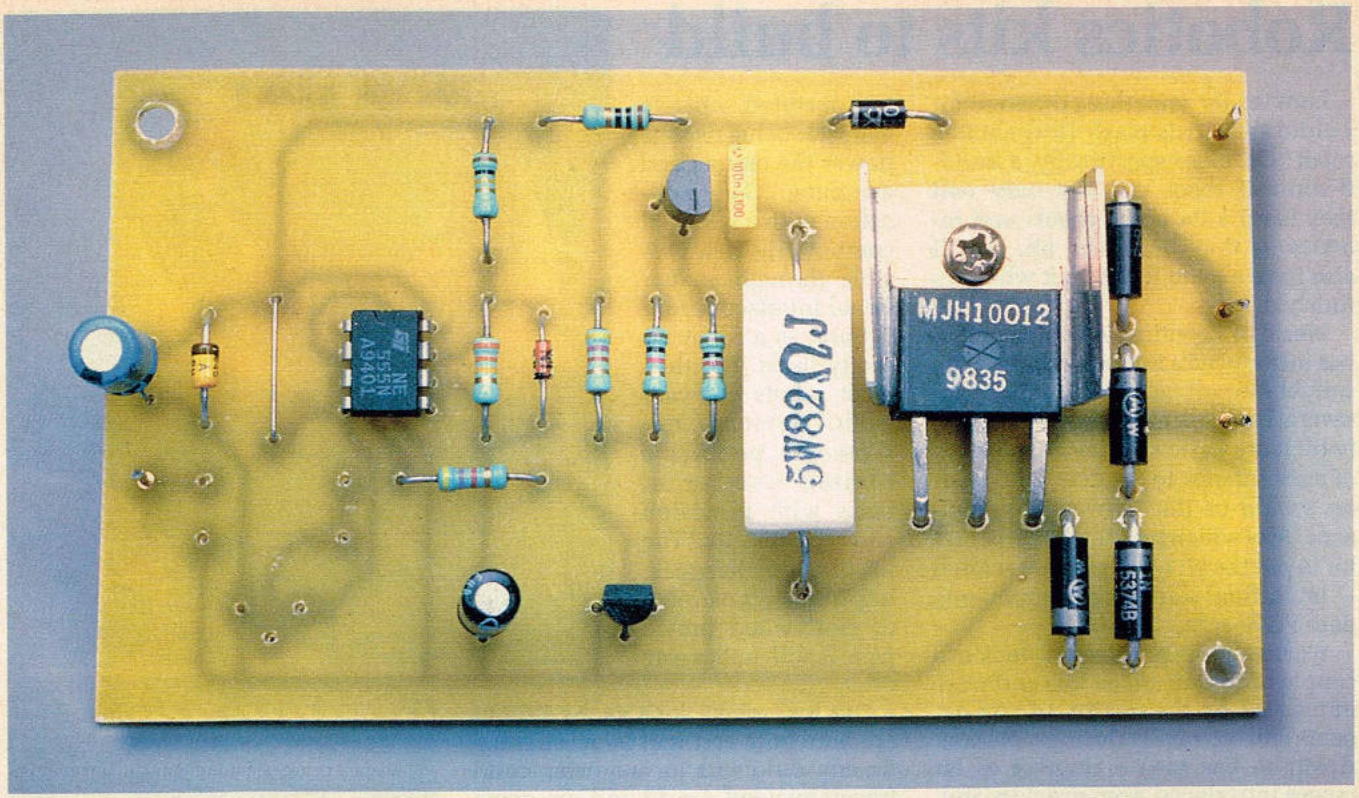
The drive, with an estimated price of $345 inc tax is already available in limited quantites through distributors and dealers. Enquiries to Hitachi Australia Ltd, 13-15 Lyonpark Rd, North Ryde, NSW 2113. Tel (02) 9888 4100, Fax (02) 9888 4188, website www.hitachi.com.au

Outdoor telecommunications NiCad from SAFT

A long life, durable Nickel-Cadmium battery intended for external telecommunications applications, has been released by SAFT Australia.

The Ultima Plus has a pocket plate design and is claimed to have a 20-year lifespan. With a generous electrolyte reserve, thermal runaway is eliminated and the battery is expected to be maintenance-free at normal temperatures. Even when operated at 40°C, top-up will only be required after 10 years, according to SAFT Managing Director, Richard Jensen.

Enquiries to SAFT Australia Pty Ltd, Unit 7, 20 Powers Rd, Seven Hills NSW. Ph (02) 9674 0700, Fax (02) 9629 9990.



Engine Immobiliser Mk.2

Protect your car from theft with the . . .

This basic engine Immobiliser kills the ignition if a thief tries to steal your car. Fit it to your car as cheap insurance and peace of mind. If a thief tries to start your car, the engine will repeatedly stall and he will move on to an easier target.

By JOHN CLARKE

While many modern cars include a comprehensive anti-theft system with ignition disable, central locking and rolling code entry, older vehicles or the less expensive models do not have this protection. The lack of engine immobilisation renders the vehicle more susceptible to theft, particularly for older style vehicles, some of which can be entered, started and driven away in just a few seconds.

You can improve the odds against your vehicle being stolen simply by adding some form of engine immobilisation. Whether it is a hidden switch which breaks the points signal from the distributor, or a more fancy method, the inclusion makes it more difficult for a thief to start the engine. But if the ignition system can be "hot wired" to effectively bypass the immobilisation wiring then it will be worse than useless.

This Engine Immobiliser shorts out the switching transistor or points which control the ignition coil. It does not produce a permanent short because it is switched on and off at a slow rate. The engine can be started with the Immobiliser in action but it will only run for about two seconds and then switch off. The engine can then be restarted only to stall again.

If the thief persists, the engine will continue to start, only to stall again

and after several tries he is likely to decide that the car is not worth the trouble.

On the other hand, if the thief decides to lift the bonnet to investigate further, it is important that the wire from the Immobiliser to the ignition coil is well hidden. Naturally, the switch to turn the Immobiliser on and off must be well concealed or camouflaged to look like one of the accessory switches, otherwise the whole subterfuge will be for nothing.

Killing the ignition

In effect, a switch is placed in parallel with the car's points or the ignition switching transistor, as shown in Fig.1 & Fig.2. Each time the Engine Immobiliser switches on, it effectively shorts out the points or the switching transistor and prevents the coil from producing any sparks.

By shorting out the points or switching transistor and diverting the coil current for just a brief period, no damage can result to the coil. But the ignition coil could be easily burnt out if the coil current was continuously diverted, as it would be if the ignition was permanently disabled by a simple switch.

Now have a look at the circuit of the Engine Immobiliser in Fig.3. It uses a high voltage Darlington transistor (Q1) which is connected in parallel with the points or the ignition transistor. Q1 can switch the coil current of several amps and can withstand the high voltages normally developed when the ignition system is functioning normally.

This circuit is quite similar to the original Engine Immobiliser which we featured in the December 1995 issue of SILICON CHIP but there are some important differences which we will mention later in this article.

IC1, a 555 timer, is connected to operate as an astable oscillator. It is powered from the ignition circuit of

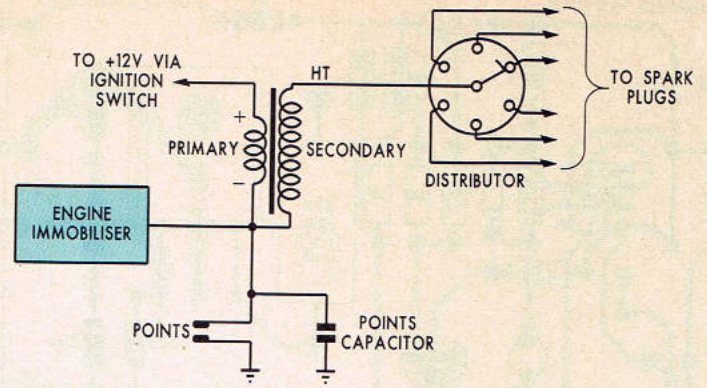


Fig.1: when fitted to a car with conventional ignition, the Immobiliser effectively shunts the points and stops the coil from producing spark voltage.

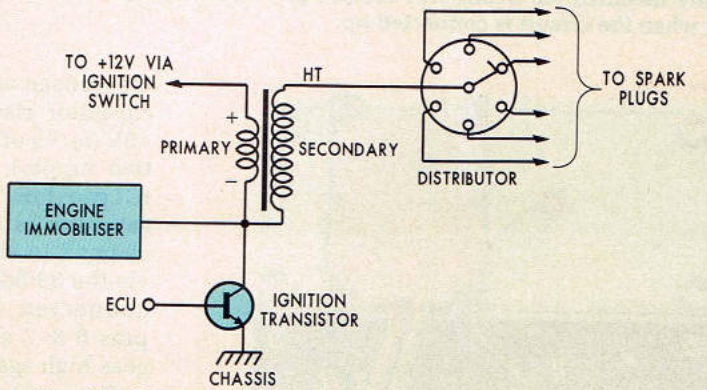


Fig.2: when fitted to a car with electronic ignition or an engine management system, the Immobiliser shunts the main switching transistor. This does no damage because the coil current is intermittently diverted through the Immobiliser.

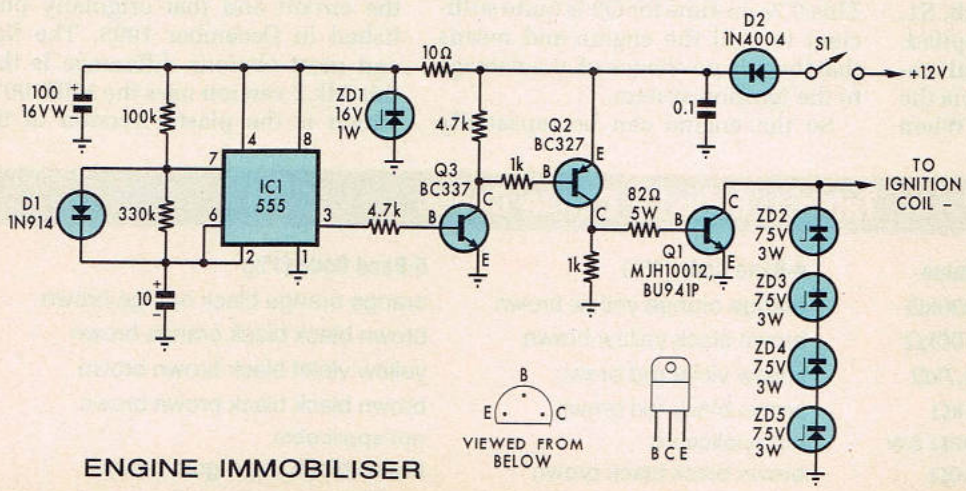


Fig.3: the circuit consists of a 555 timer which cycles the transistors on and off to periodically shunt the ignition and hence stall the engine.

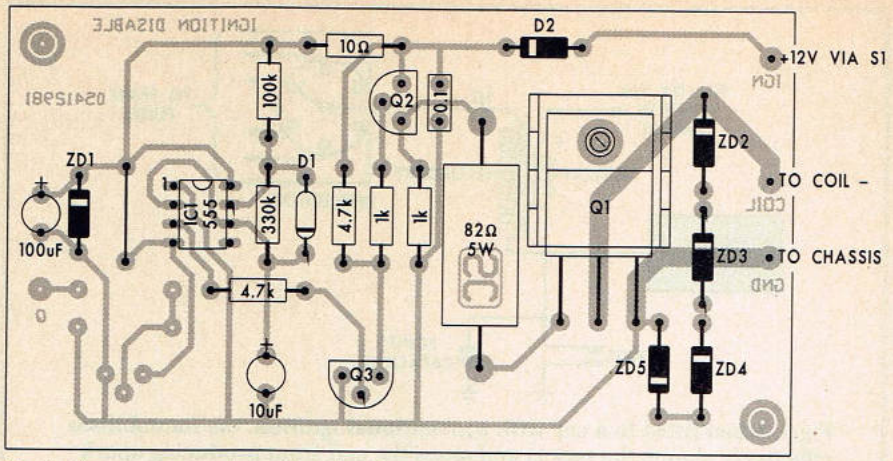
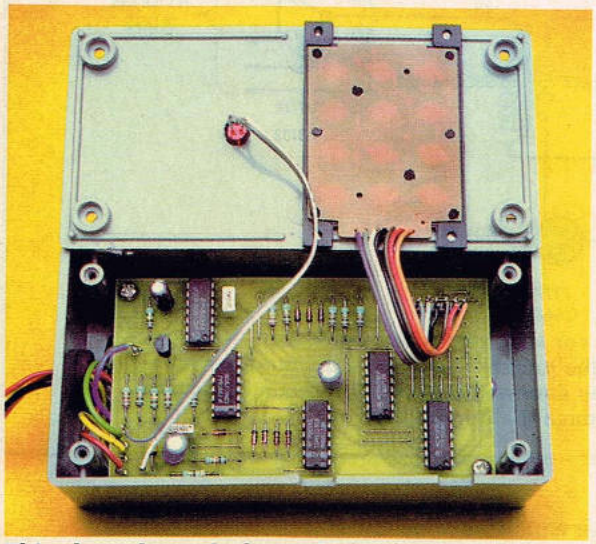


Fig.4: the component overlay for the PC board. Note that the zener diodes must be installed the right way around otherwise the circuit won't work. If the 3W zeners are installed the wrong way around they could be burnt out by the coil current when the circuit is connected up.



This photo shows the keypad version of the Engine Immobiliser, to be published next month. The keypad circuit board mounts above the Engine Immobiliser board in a standard plastic case.

the vehicle via the enable switch, S1. Initially, when power is first applied, pin 3 of IC1 goes high. The 10µF capacitor at pin 2 is then charged via the 100kΩ resistor and diode D1. When the voltage across the capacitor rises above +8V (ie, $^2/_3$ of the positive supply), pin 3 of IC1 goes low. The 10µF capacitor is then discharged to about +4V via the 330kΩ resistor connected between pins 6 & 7 and pin 3 goes high again.

The cycle then continues with pin 3 being switched high for about 0.7 seconds and low for 2.3 seconds.

Each time pin 3 of IC1 is high, Q3, Q2 & Q1 are switched on and so the ignition coil is prevented from producing its normal primary voltage and the engine will be stalled. This 0.7s on-time for Q2 is quite sufficient to stall the engine and means that there is no chance of any damage to the ignition system.

So the engine can be repeatedly started and will just as surely stall each time.

One important feature, which may not be immediately obvious, is that the Immobiliser does not do any damage to the car's ignition system if the thief leaves the car stalled and hot-wired. The Immobiliser will continue its cycle of 0.7s on and 2.3s off indefinitely but no damage should result apart from the possibility of the battery becoming discharged.

One other minor point is that when power is first applied to the Immobiliser circuit, as when the ignition is first switched on, pin 3 of IC1 will be high and so Q1 will be on, pulling the negative side of the coil low and thus preventing any sparks from being delivered for about one second. However, most cars need to be cranked for at least a second to start them so there is really no noticeable effect on starting the car.

Power for the Immobiliser comes from the ignition switch and the enable switch S1. It is fed via diode D2 which protects transistors Q2 & Q3 against reverse connection of the supply while the associated 0.1µF capacitor decouples the supply from hash. IC1 is protected from voltage transients with the 16V zener diode ZD1, together with the series 10Ω resistor and 100µF decoupling capacitor.

Construction

The Engine Immobiliser circuit is accommodated on a PC board measuring 106 x 60mm and coded 05412981. The component overlay for the board is shown in Fig.4.

Before discussing the construction details, we need to mention a number of differences between this version of the circuit and that originally published in December 1995. The first and most obvious difference is that this Mk.2 version uses the MJH10012 which is the plastic version of the

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	330kΩ	orange orange yellow brown	orange orange black orange brown
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	82Ω 5W	not applicable	not applicable
❑	1	10Ω	brown black black brown	brown black black gold brown

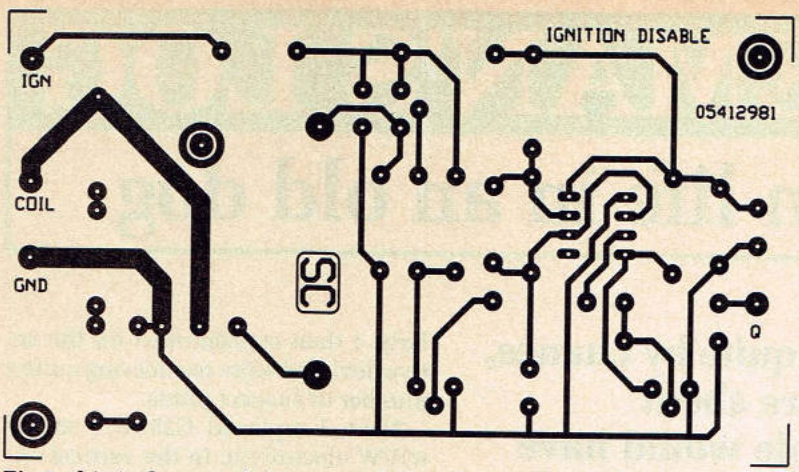


Fig.5: this is the actual size artwork for the PC board. Check your board carefully before installing any of the parts.

MJ10012 TO-3 power transistor.

An alternative transistor which may be supplied in some kits is the BU941P (manufactured by 57 Microelectronics). While the plastic Darlington high voltage transistor should be cheaper it does require a small heatsink.

The second point of difference is that there is provision on the board for another transistor and this will be used in a keypad-operated Engine Immobiliser to be published next month. The version being published this month has the virtue of simplicity; next month's version offers more bells and whistles and the security of a keypad to disable it.

Now that we've got those points out of the way, we can discuss assembly of the board. You can begin construction by checking the PC board for shorts between tracks, breaks in the pattern or undrilled holes.

You will need to fit PC stakes at the external wiring points (four) and then insert the links using the tinned copper wire.

The resistors can be installed next and you can use the colour codes in Table 1 as a guide to selecting each value. Alternatively, you can use a digital multimeter to measure each resistor before it is soldered in.

The diodes can go in next, taking care with the polarity of each. Make sure that you use the 1N914 or 1N4148 type for D1 and 1N4004 for D2. The 16V zener diode ZD1 is quite small and may be marked 1N4745 while the four 75V 3W zeners (which may be marked 1N5374) are quite a lot larger.

Transistors Q2 & Q3 are positioned as shown but make sure you don't get them swapped around; Q2 is a BC327 while Q3 is a BC337. Transistor Q1 is mounted on a small heatsink and secured with an M3 screw and nut to the PC board.

Next, insert the 555 IC and the three capacitors, making sure that the IC and the electrolytic capacitors are installed the right way around. The 0.1µF capacitor may be marked as 100n or 104, being the IEC and EIA codes, respectively.

Testing

To test the circuit, connect it to a 12V DC supply or battery. There is no need to connect a coil to the collector of Q1. Connect your multimeter, set to measure 12V DC, to check the voltage at pin 3 of IC1. You can do this most conveniently by connecting to the 4.7kΩ base resistor for Q3.

Now apply power and check that pin 3 goes high immediately and then drops low after about a second. It should then stay low for 2.3 seconds or thereabouts, then go high for 0.7s and so on. You can then check the sequence at the collector of Q3 and the collector of Q2. Q3 will invert the voltage from pin of IC1 and Q2 will invert it back again.

Finally, you can verify that the high voltage transistor Q1 comes on by measuring the resistance between its emitter and collector. The transistor will be on when the resistance is low and off when its resistance is high.

If the circuit operates properly you are now ready to install it into your vehicle. The board can be housed in several ways. It can be mounted in a standard plastic case measuring 130 x 67 x 43mm or it could be sheathed in heatshrink tubing.

Parts List

1 plastic case, 130 x 67 x 43mm
1 PC board, code 05412981, 106 x 60mm
4 PC stakes
1 mini heatsink, 19 x 19 x 9.5mm
1 M3 x 9mm screw
1 M3 nut
1 1m length of heavy duty black automotive hookup wire
1 1m length of heavy duty red automotive hookup wire
1 1m length of light duty red automotive hookup wire
1 1m length of heavy duty yellow automotive hookup wire
1 150mm length of hookup wire

Semiconductors
1 555 timer (IC1)
1 MJH10012, BU941P power Darlington transistor (Q1)
1 BC327 PNP transistor (Q2
1 BC337 NPN transistors (Q3)
1 16V 1W zener diode (ZD1)
4 75V 3W zener diodes (ZD2-5)
1 IN4148, 1N914 diode (D1)
1 1N4004 1A diode (D2)

Capacitors
1 100µF 16VW PC electrolytic
1 10µF 16VW PC electrolytic
1 0.1µF MKT polyester

Resistors (0.25W, 1%)
1 330kΩ
1 100kΩ
1 4.7kΩ
1 1kΩ
1 82Ω 5W
1 10Ω

Miscellaneous
Automotive connectors, solder.

Find a suitable position under the dashboard to mount the unit and then locate the fused side of the ignition circuit and the fused side of the battery supply.

The wiring to these points should be made using automotive connectors. Also you will need a chassis point to connect the ground supply of the circuit to the battery negative terminal. This can be an existing screw in the bodywork or a separate self-tapping screw which secures the eyelet terminal for the ground lead in place. The connection to the ignition coil should be made with an eyelet terminal. Try to conceal this wire as much as possible. **SC**

SERVICEMAN'S LOG

There's often life in an old dog

I didn't plan it that way but, quite by chance, all three stories this month are about equipment which many people would have consigned to the scrap heap. But as I found, there is often life in an old dog yet.

The 10 year old Philips stereo TV set (Philips 28CT8893/75Z KR 6687R 2B-S chassis) brought in by Mr Evans was just on the point of its use-by date. Most of these sets suffer low-emission tubes by now and are struggling to give any sort of picture. However, this set looked immaculate and the owner assured me that he only watched it on Sundays for the religious programs! (If you believe that, you'll believe anything).

Anyway, he was complaining of what is a typical problem with this model set – either no picture or the picture taking a very long time to appear, usually with a horizontal white line at the top first.

I was glad when he had gone because access to this set is only really viable when the set is on its side or upside down and some people become somewhat anxious when their pride and joy is placed in such an unusual position.

First, I resoldered all the connections to the horizontal output transformer and the chopper transformer rivets. The rivets were designed to reduce dry joints but failed spectacularly. I then concentrated on the active devices before resoldering quite a number of suspect joints.

Next, I replaced C2571, a 100µF 63VW electrolytic in the vertical circuit. This is obligatory as this capacitor can cause all sorts of bother in the vertical output and timebase stages. Now I was ready to fire it up and see what I had achieved. It still took too long for the picture to appear, and when it did the picture lacked contrast. Oh dear, I thought, that tube is not looking too good.

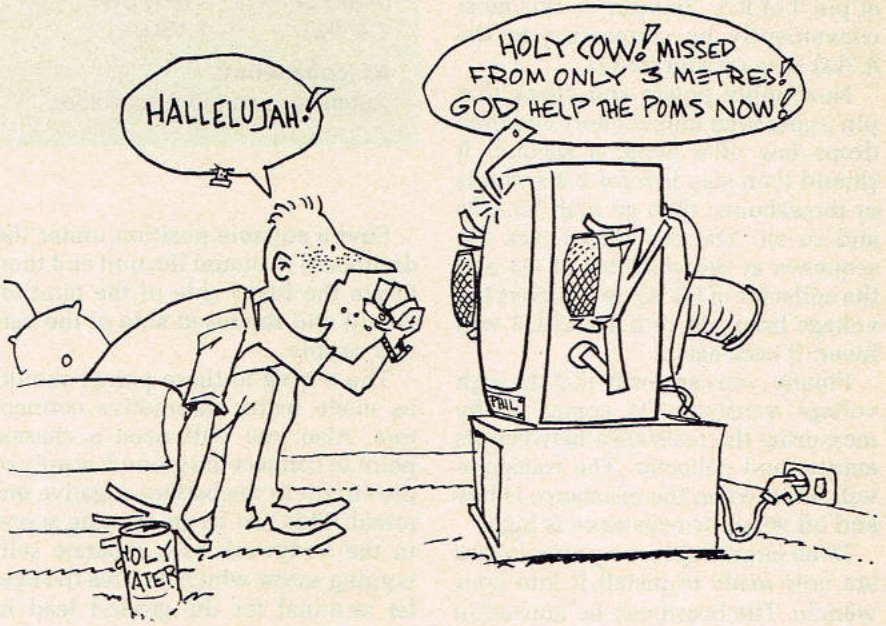
This set employs a rather elaborate automatic greyscale and beam current limiter using a TDA4580 chip (IC7310). This controls the beam cut-off point stabilisation for the CRT. However, problems occur when the tube emission is so low that it is outside the capture range of the IC.

There is a modification to cope with tube ageing and that is to fit a resistor from the 12V rail to pin 26 of IC7300. This alters the cut-off control point within the IC. The value of this resistor varies from 82kΩ to 33kΩ, depending on how bad the tube is. On bad sets, it can take as long as half an hour for the tube to come on without this modification.

The other thing one can do, which is really only short term, is to increase the tube heater filament voltage by shorting out L5465 and/or L5466. I decided on this trick first, as a temporary measure, to confirm whether it was a low emission tube or not.

Unfortunately, this action was not conclusive. The picture did come on quicker but it was still lacking contrast, so I fitted an 82kΩ resistor to pin 26 of IC7300 and began tracking down the contrast problem.

First, I confirmed that the contrast control itself was working. I then disconnected TR7488 (BC548), to see if the beam limiter was cutting in on the contrast. There were no problems here though, the voltage on pin 19 of IC7300 correctly swinging from 1.5-3V.



THE OWNER ASSURED ME THAT HE ONLY WATCHED IT ON SUNDAYS FOR THE RELIGIOUS PROGRAMS...

Next, I checked the pulses to pin 10 against CRO waveforms 43 and 44 and again these were OK. These gating pulses are generated in the sync chip (IC7550 TDA8370/V2, pin 9) and feed various chrominance and luminance circuits. Any faults here can produce very similar contrast symptoms, as can an incorrectly set RF AGC control in the tuner IF module (as I discovered on one occasion).

Anyway, to cut a very long story short, I was prodding away on IC7300, looking very technical, when I noticed that I had missed resoldering a very dry joint on pin 28. This pin is the blanking input from the Teletext decoder module (plug/socket 6M9/6T9). Exactly how this was causing the problem I still don't really understand, as the Teletext wasn't in use at that time. However, resoldering the pin completely fixed the problem and the set showed a surprisingly good picture.

The 82kΩ resistor which I had added earlier was now clearly superfluous, so I removed it. Mr Evans was delighted with the final result when I demonstrated the set on soak test – sitting right way up of course.

A crook Sony

Talking about sets that are a bit long in the tooth, this next set is in a similar category but even older. I mentally subtitled it "A crook Sony" and it really was crook. However, age was about all that this set and the previous set had in common.

I seem to have serviced a lot of Sonys recently but, to be fair, this is really because they are one of the market leaders and there are a lot of Sony TV sets out there. Sony sets are generally very reliable but one of the worst I ever had to deal with was this 1986 KV2264AS.

Normally, I avoid 10-year old TV sets like the plague (let alone one that's 12 years old) but a colleague, Bill, had been caught with this one. Initially, it had looked so easy to fix but after two weeks, he still hadn't cracked it. And that created problems because he was about to go on a long-deserved holiday to Bali and the customer was screaming.

Could I please help him out? Well, what can one do? – you have to help if it's a mate! So idiot me said "OK, bring it over". My mate was around in nanoseconds, with the set in his arms.

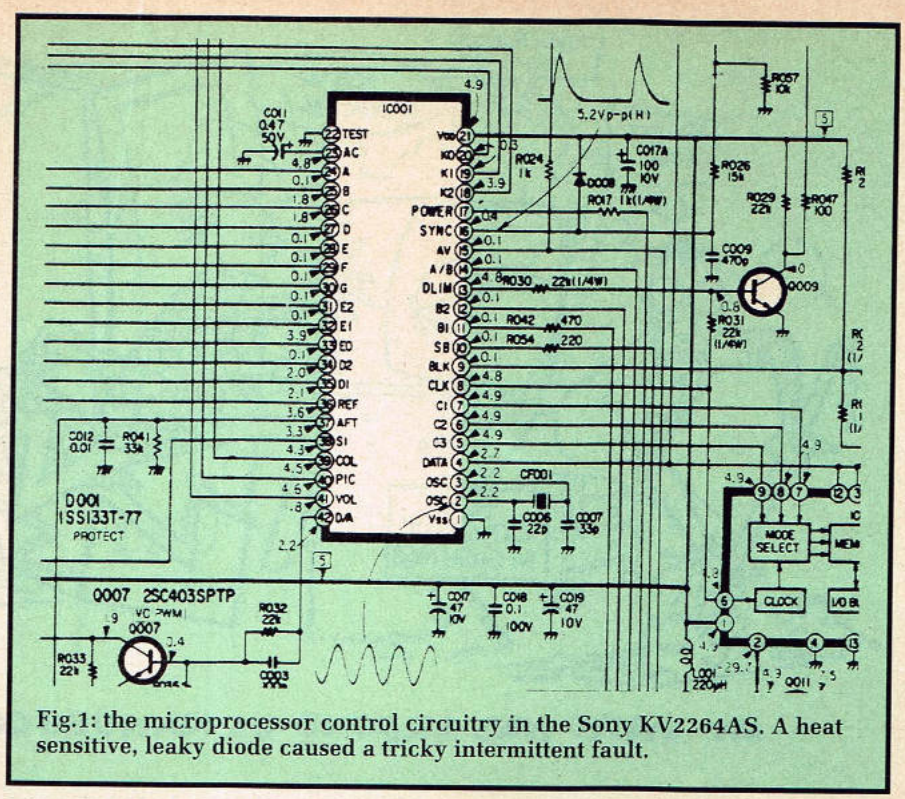


Fig.1: the microprocessor control circuitry in the Sony KV2264AS. A heat sensitive, leaky diode caused a tricky intermittent fault.

I asked him where the fire was but this went straight over his head. Fairly obviously, he was somewhat preoccupied with all the last minute things that he had to sort out before going away. He apologised for being in such a rush and warned me that there might be collateral damage; he had had to brake hard to avoid a dog on the way over and, as he put it, ". . . the set didn't like it".

Anyway, he plonked the set down and rushed out the door, shouting over his shoulder that the fault was no sound or picture. And then he was gone.

When the dust had settled, I dug up the circuit for the RX chassis and removed the back. Unlike the well-cared for and immaculate Philips, the whole set was in pretty poor condition and looked as though it had had a hard life. It was amazing really that someone still considered it worth fixing but I suppose a 53cm remote stereo TV set is still too good to dump.

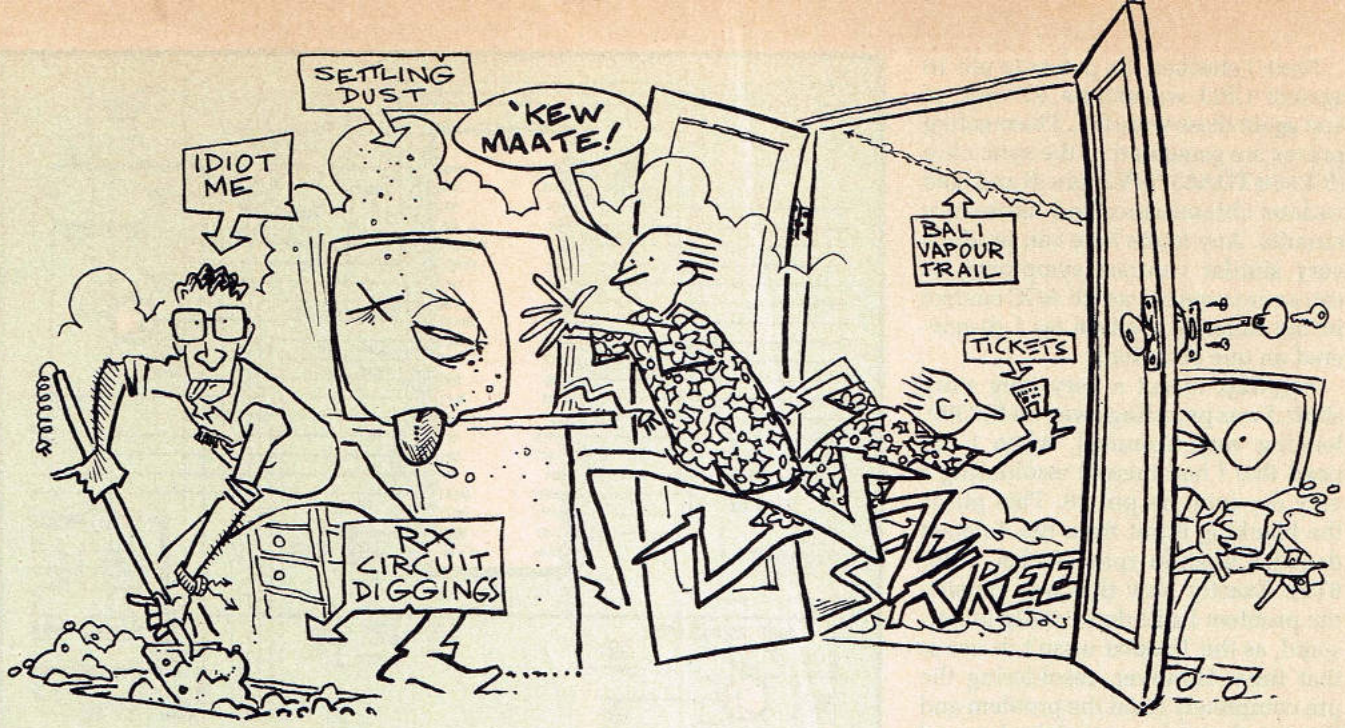
On switch on, the set displayed a raster but there was no picture or sound, as my colleague had indicated. The first thing I did was use compressed air to blow out the voluminous layers of dust. This done, I set about measuring the various voltage rails from the switchmode power supply module. All were reasonable except the 6V rail, which was very low.

Closer examination revealed that the heatshrink around C655 (220µF, 25V), the main reservoir capacitor for the 6V rail, had shrunk. It obviously needed replacing but when I removed the module and examined the underside of the PC board, I was amazed that the set ever worked at all. There were dry joints everywhere.

I fitted another electro and spent the next 15 minutes reworking the whole board before reassembling it. On switch on, I was rewarded with a bright picture but it was predominantly yellow and obviously lacking any blue. Checking out the picture tube socket board revealed more dry joints. I reworked these but this didn't restore the missing blue, although wiggling the board brought it back momentarily.

I looked more carefully at the socket and could see the telltale signs of hairline cracks. Ah, ha! – this is what "the set didn't like". Installing jumpers across the cracks restored the blue permanently and after turning down the screen G2 control, it displayed quite a good picture for a set this old.

Well, I thought, that was easy. I couldn't quite see what all the fuss had been about and decided to leave



MY MATE WAS AROUND IN NANOSECONDS...

the set on soak test while awaiting my friend's return.

Bali calling

A few hours later, I was surprised to get a long-distance phone call. After a lot of line noises, a much more relaxed Bill apologised for dumping the set on me at such short notice and asked if I'd seen the fault yet? Well, of course I'd seen it but what did he mean by "yet"?

"Ah, well, it's intermittent and takes hours to go off", Bill replied. He then went on to inform me that he had initially thought that the microprocessor, IC001, was at fault and had replaced it but that hadn't fixed the problem.

I told him what I had found and that the set was going fine now and had been on for a few hours already. He expressed surprise but was really insistent that he didn't think I had fixed it and urged me to leave it on test. In the meantime, Bill really had to go as his ice-cold martini was getting warm by the pool – and hey, first things first.

Well, unfortunately, he was right; the next day, after it had been on for more than four hours, it began to intermittently give no sound or picture. How I hate jobs like this. I was beginning to think murderous thoughts about Bill too. It meant tying down valuable bench space and equipment for hours on end, monitoring life support systems within the set until the fault (or faults) occurred.

Eventually, the fault did show and I checked all the voltage rails from the power supply, as well as the auxiliary rails on the motherboard, but everything was OK. Because I had already found dry joints on the power supply board and CRT socket, I thought that it would be worth checking out the tuner IF module and I wasn't disappointed – it too was riddled with dry joints but resoldering these didn't fix the problem.

Next, I tipped the set onto its front and examined the motherboard. The soldering here was quite reasonable and I found only two suspicious connections. I resoldered them but the fault persisted.

Since it took hours for the fault to occur, it implied that heat was the most likely candidate to cause the fault, so freezing might also temporarily fix it. Anyway, I spent another half-hour on the job and expended a complete can of freezer but I did find a clue. When freezing around one end of microprocessor IC001 (the one Bill had replaced), there was a slight change and the picture and sound came back floatingly. I was beginning to suspect that the new IC was also faulty but then I noticed that freezing diode D008, between pins 16 and 21, had much the same effect.

I checked the voltage on D008's cathode and this correctly measured 4.9V, which is the VDD supply rail to IC001 and other components. The anode of this diode is connected to the sync input of IC001 (pin 16) and this input should be at 0.4V but, in fact, varied around 1.4V. Because D008 is only a cheap small-signal silicon diode (ISS133T-77), I decided the simplest course was to replace it with a 1N4148 and see if that had any effect.

And that was it – the diode was the culprit. The voltage on its anode was now exactly 0.4V and heating and freezing it made no difference. Apparently, with the old diode in place, the voltage on the sync rail had switched off the sync to the IC and muted the sound and picture.

Curious, I measured the old diode with a variety of digital and analog meters and a couple of component analysers. They all indicated that the diode was perfect and not the slightest bit leaky. However, when I dug out my 23-year-old DSE Peak (Hioki) AS-100D 100kΩ/V multimeter (with a 12μA fsd torsion band movement and a 22.5V battery), the reverse leakage measured 200kΩ and it varied with temperature (the other meters all indicated infinity).

It is to my immense regret that me-

ters like this aren't made any more – even the batteries are no longer obtainable. I would be happy to swap a brand new digital meter for a good working secondhand meter like this one. I once even wrote to Hioki on this subject and was told there was no demand at all for these meters.

Ah, well – such is life. And as for that rotten Bill, he had the time of his life at my expense!

More ancient gear

"I'll pick this in one!" How often have you boasted this to yourself, only to come a gutser? Or how often has a problem appeared so daunting, that you hesitated to tackle it only to find that it was a snack?

Actually, I had no such thoughts along these lines when this story first started. It all began when a customer plonked a computer monitor on the counter and asked "Can ya fix this?". "This" was an ancient Acer 500 (model MM211) 14-inch monochrome unit. And the problem? He had been running a program when the screen suddenly changed from a normal black background to flaring white. "And the text had gone all funny and blurred and there were a couple of tilted (retrace) lines across it."

I didn't recognise the monitor immediately and I doubted whether I could find a circuit for it. The only good point was that the customer wasn't in a hurry, so I told him to leave it with me and I'd take a closer look.

Subsequently, the few biological kilobytes remaining in the old grey matter began to work. Yes, I had handled one before, several years ago and, yes, I should have a circuit somewhere. It was a long search but I found it. And then it all came back. On that occasion, I had found a fault in the power supply (the 12V regulator had failed). It was an obvious fault and was easily fixed, as described in the November 1992 issue.

Unfortunately, the circuit wasn't much help. It was an umpteenth generation copy and had gone through a fax machine at least once. The circuit as such could be followed but few values or component numbers could be read.

And there was another problem. I had no compatible computer with which to test it. I would have to bring the customer's computer to the shop or take the monitor to the computer.

I took another look at the circuit. An obvious starting point was the brightness control and its associated circuitry. I identified this by starting at the picture tube grid (G1) and working backwards. I found it easily enough; it was marked VR30-(?).

This pot was connected between two rails derived from EHT transformer taps at pins 5 and 7 (some of the few markings large enough to read). Pin 7 generated a positive rail via a surge resistor, a diode and an electrolytic filter capacitor. Pin 5 generated a negative rail in a similar manner, with the diode and electro reversed. Between these two tappings was pin 6, to chassis. It was easy to visualise how this network functioned, or how it could cause excessive brightness if something failed.

That was the simple scenario. A more complex one would involve the video driver transistor which is directly coupled to the picture tube cathode. The collector is supplied by the pin 7 rail, thereby making the cathode positive and the grid negative.

If the driver transistor's operating conditions had been upset, the brightness circuit could also have been upset. Or there could be a fault further back along the line, involving the next video transistor which is also direct coupled. Next was a 14-pin IC and I gave up at that point.

Feedback

My thanks to Mr T. Robinson for his very informative letter in Mailbag for October 1998, concerning car radios and vibrators.

I couldn't agree more, Mr Robinson. What a pity I didn't know that plug-in solid state vibrators were available from Arizona, USA – I certainly would have saved a lot of time and bother, not to mention grey hairs. But I don't subscribe to US magazines and regret that I have never heard of Antique Electronic Supply (actually, I am struggling to know where Arizona is)!

However, you will be pleased to learn that I did consider the increased voltage when I substituted diodes for the OZ4 valve. I added a 100Ω resistor but it was too late to alter the circuit before reaching the printing deadline.

Well, not really. I put the unit aside while I tackled more urgent jobs but I kept it in the back of my mind. Which of those two theories was the more likely one? I had probably paid less attention than I should have to the customer's fault description. What was it he said? – "the text was all funny and blurred".

But it wasn't the text description that hit me; it was the fact that there was any indication of text at all. This suggested that the video chain was working right up to the picture tube grid. If so, the probability of the fault being in this part of the circuit was significantly reduced.

And that put suspicion squarely back onto the brightness control circuit and its two rails. And the increased brightness would make the negative rail the prime suspect. Which was where I began to kid myself that I could pick it in one, straight off the circuit. At least it was worth a try.

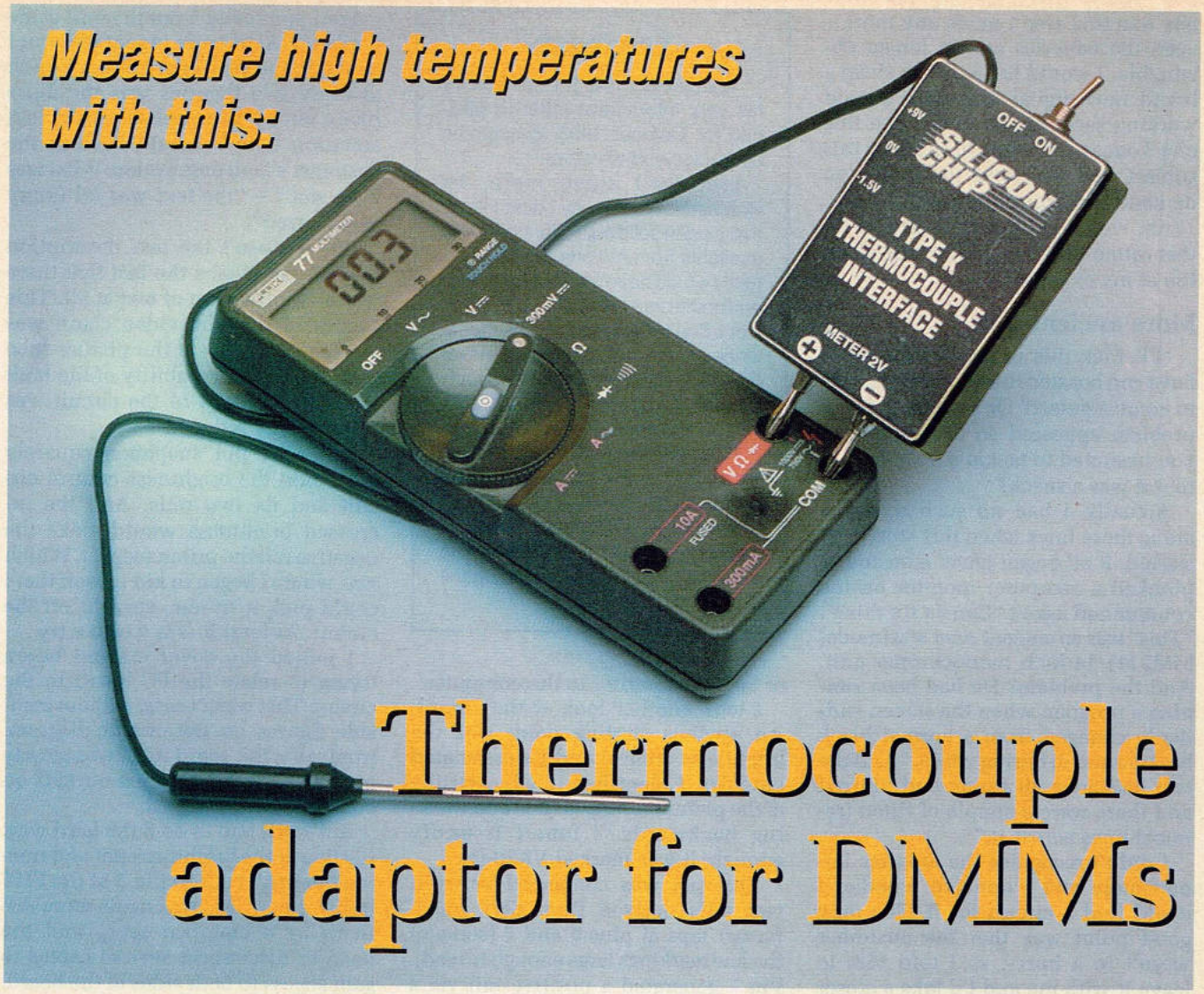
I pulled the cover off and began trying to relate the PC board to the circuit. That wasn't easy, without readable figures on the circuit diagram. Ironically, the board itself was clearly marked for each component and on both sides of the board.

But I still had to do it the hard way, starting at the brightness pot and tracing the track back to pin 5 of the EHT transformer. This was made more difficult by a cramped setup and the need to disconnect several cables to gain access to both sides of the board.

Anyway, I finally pinpointed the three negative rail components: ie, the electrolytic capacitor, the diode and the surge limiting resistor. An in-situ ohmmeter check gave a fair indication of capacitance and ruled out any leakage. A similar check cleared the diode.

That left only the resistor. Surely not – there was no sign of damage or overheating. But that was it; although marked 47Ω, it actually measured 55kΩ. I replaced it, put everything together and took the first opportunity to take it back to the customer. Together we plugged it in and checked it out. It went like a bought one.

So that was it. Using only the customer's description, a grotty circuit diagram, and my own grey matter, I was able to fix the monitor without even switching it on. No, I'm not boasting. I was lucky. And you don't strike it that lucky very often. **SC**



Thermocouple adaptor for DMMs

How many times have you wondered how hot an object is? It might be the heatsink in your latest project, the inlet or exhaust manifold in your car or anything else that's hot or cold. Now you need wonder no more with this thermocouple adaptor for digital multimeters.

By RICK WALTERS

This Thermocouple Adaptor for DMMs can use any of several readily available type K thermocouple probes. The probe is plugged into this adaptor which plugs directly into your digital multimeter. Any digital multimeter will be suitable whether it has a 3.5-digit (1999), a 4-digit or a 4.5-digit display.

In essence, this Thermocouple Adaptor is a temperature to voltage converter. Its output is 0V at 0°C and this increases (or decreases for negative temperatures) at the rate of 10mV/°C. This means that the temperature can be read directly in degrees C on a digital multimeter that's set to an appropriate DC voltage range. All you have to remember is to divide the reading in millivolts by 10.

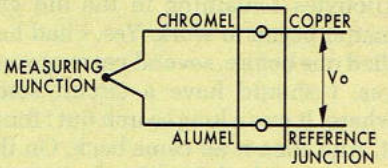
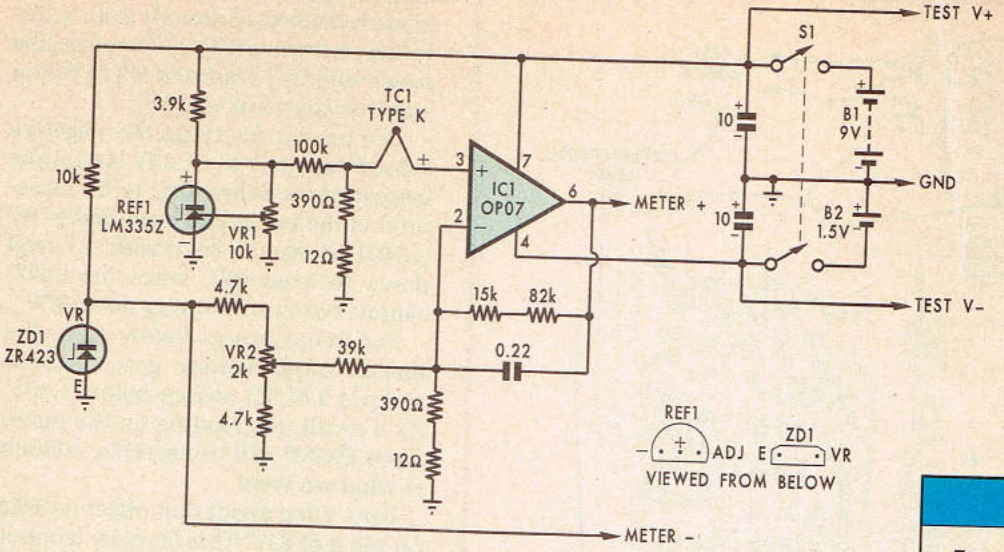


Fig.1: the basic scheme for a thermocouple. It consists of two dissimilar metal wires joined together to form a measuring junction. The open end of the wires then becomes the reference junction.

The thermocouple probe you choose will depend on the temperature you want to measure and how much you want to pay. You can pick up a low cost bare-wire thermocouple which



TYPE K THERMOCOUPLE ADAPTOR

Fig.2: the complete circuit for the Thermocouple Adapter. The ambient temperature is sensed by REF1 and this produces a compensating voltage which is added to the thermocouple's output. This output is amplified by IC1 which then drives the meter (DMM). ZD1 provides the reference voltage for pin 2 of IC1, while VR2 is used for calibration.

will cover the range from -40°C to 250°C or you can go for a more expensive high-temperature (type K) probe capable of measuring from -50°C to 600°C.

"What's a thermocouple?" you may ask. Basically, a thermocouple consists of two wires which are of dissimilar metals (in this case Chromel and Alumel). The wires are connected at one end, which becomes the measuring junction while at the other end the wires are connected to a reference junction.

Confused? Fig.1 shows the basic scheme. The measuring junction is placed on the object whose temperature we want to measure. We then use a meter circuit to measure the voltage developed across the reference junction which is normally at ambient temperature (ie, room temperature). This voltage will be proportional to the temperature difference between the measuring junction and the reference junction.

This voltage effect is known as the Seebeck coefficient and is about 40.6µV/°C for a type K thermocouple. Note that the change in output voltage per °C is only approximately linear over a small temperature range (see Table 1).

As you can see from Table 1, we are dealing with very small voltages here. This means that we need a high-gain circuit and we must take precautions to ensure that no spurious voltages are introduced into it.

The adaptor described here covers the temperature range from -50°C to around +600°C with a reasonable accuracy of a few degrees at the extremes.

Reference junction temperature

In the laboratory, a reference junction can be held constant at 0°C using an ice bath but that's not practical for a portable instrument. Instead, in this circuit, the reference junction floats at the ambient temperature. This means that we need to have some way of compensating for ambient temperature variations in order to obtain accurate readings.

The way around this problem is to use another temperature sensor to generate a voltage that's proportional to the ambient temperature. This compensating voltage is then added to the thermocouple output and this effectively nulls out any effect from ambient temperature changes. If the ambient temperature goes up, so does the compensating voltage and vice versa.

In other words, for a given input temperature at the measuring junction, the output voltage from the Thermocouple Adaptor remains constant, regardless of the ambient temperature.

Chromel & Alumel: What Are They?

We've mentioned that a type-K thermocouple uses wires of Chromel and Alumel but what are they? You might guess that they are alloys and you'd be right. Chromel is an alloy of chromium and nickel which is commonly used in heating elements, while Alumel is an alloy of aluminium, manganese, silicon and nickel.

Table 1

Temperature °C	Thermocouple Output (mV)
-50	-1.889
-25	-0.968
0	0
25	1.00
50	2.022
100	4.095
200	8.137
300	12.207
400	16.395
500	20.640
600	24.902

Circuit details

Let's now refer to Fig.2 for the full circuit details. The ambient temperature is sensed by REF1, an LM335Z solid-state temperature sensor. This device generates an output voltage of 10mV per K(elvin). Because 273.12K is equivalent to 0°C, its output will be (nominally) 2.7312V at 0°C and will vary by 10mV for each Celsius degree rise or fall.

This voltage change is reduced to 40.6µV/C° (ie, the same as the Seebeck coefficient for the K-type thermocouple) by feeding the LM335Z's output into a voltage divider. This divider consists of the 100kΩ, 390Ω and 12Ω resistors and its output is connected

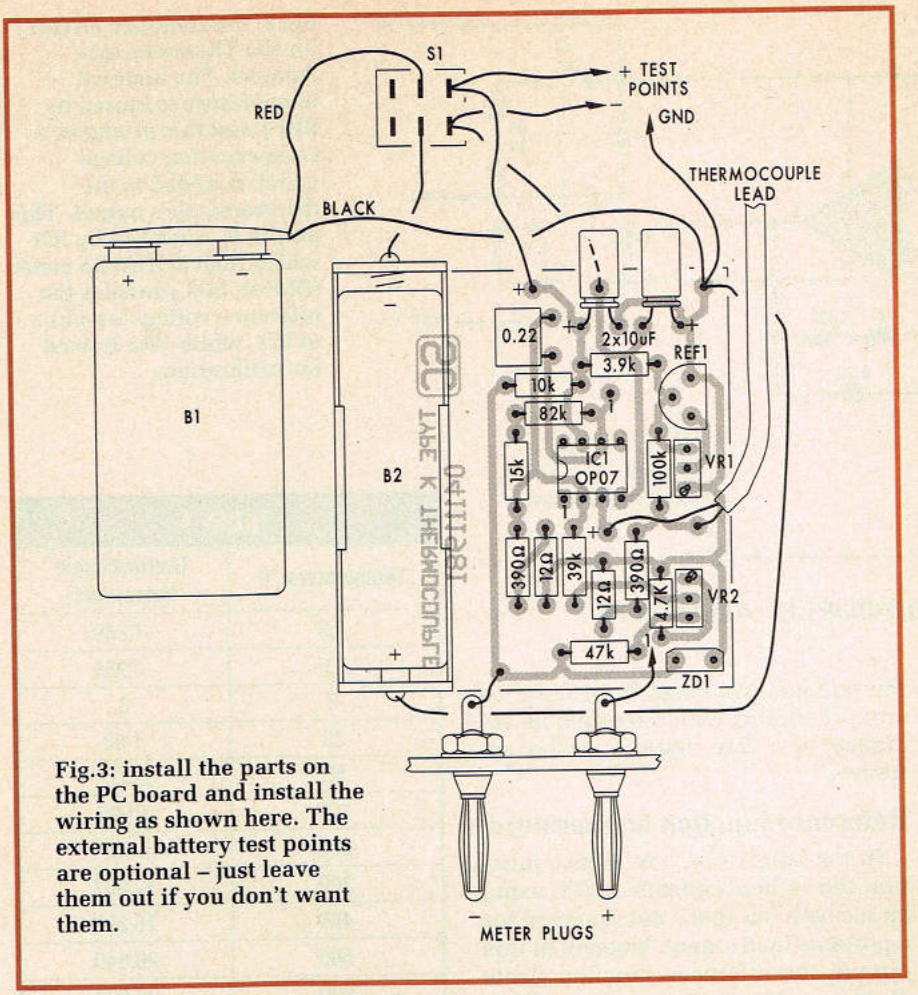


Fig.3: install the parts on the PC board and install the wiring as shown here. The external battery test points are optional – just leave them out if you don't want them.

in series with the negative lead of the thermocouple.

As a result, the thermocouple's output is automatically compensated for ambient temperature variations. We still have one small problem though. As stated, the LM335Z has an output of 2.71312V at 0°C, which means that the output from the voltage divider sits at 11.73mV when the ambient temperature is 0°C. This 11.73mV offset voltage appears on pin 3 of op amp stage IC1 and needs to be cancelled out so that the multimeter reads 0V when the probe is measuring 0°C.

One way of doing this would be to feed an equal offset voltage into the inverting input (pin 2) of IC1. In practice, we actually do feed in an offset voltage but it's a bit more complicated than that, as we shall see.

Take another look at the circuit. As shown, the op amp's output (pin 6) connects to the meter's positive terminal, while the meter's negative terminal is connected directly to a +1.25V voltage reference (ZD1). Therefore, the meter will only read zero when the op amp's output is at +1.25V.

The reason for tying the negative side of the meter to +1.25V is to allow temperatures below 0°C to be measured. If the meter had been tied to 0V (GND), it would be unable to read down to even 0°C, since the OP07 cannot swing all the way down 0V.

For temperatures below zero, the thermocouple voltage goes negative and pin 3 of IC1 swings below 1.25V. As a result, the reading on the meter (your DMM) will be negative – which is what we want.

Now what about that offset voltage on pin 2 of IC1? This is set by trimpot VR2 which forms part of a voltage divider network across ZD1 (the 1.25V reference). In practice, VR2 is used to adjust the offset voltage at pin 2 of IC1 so that pin 6 sits at 1.25V at 0°C or 1.45V at 20°C.

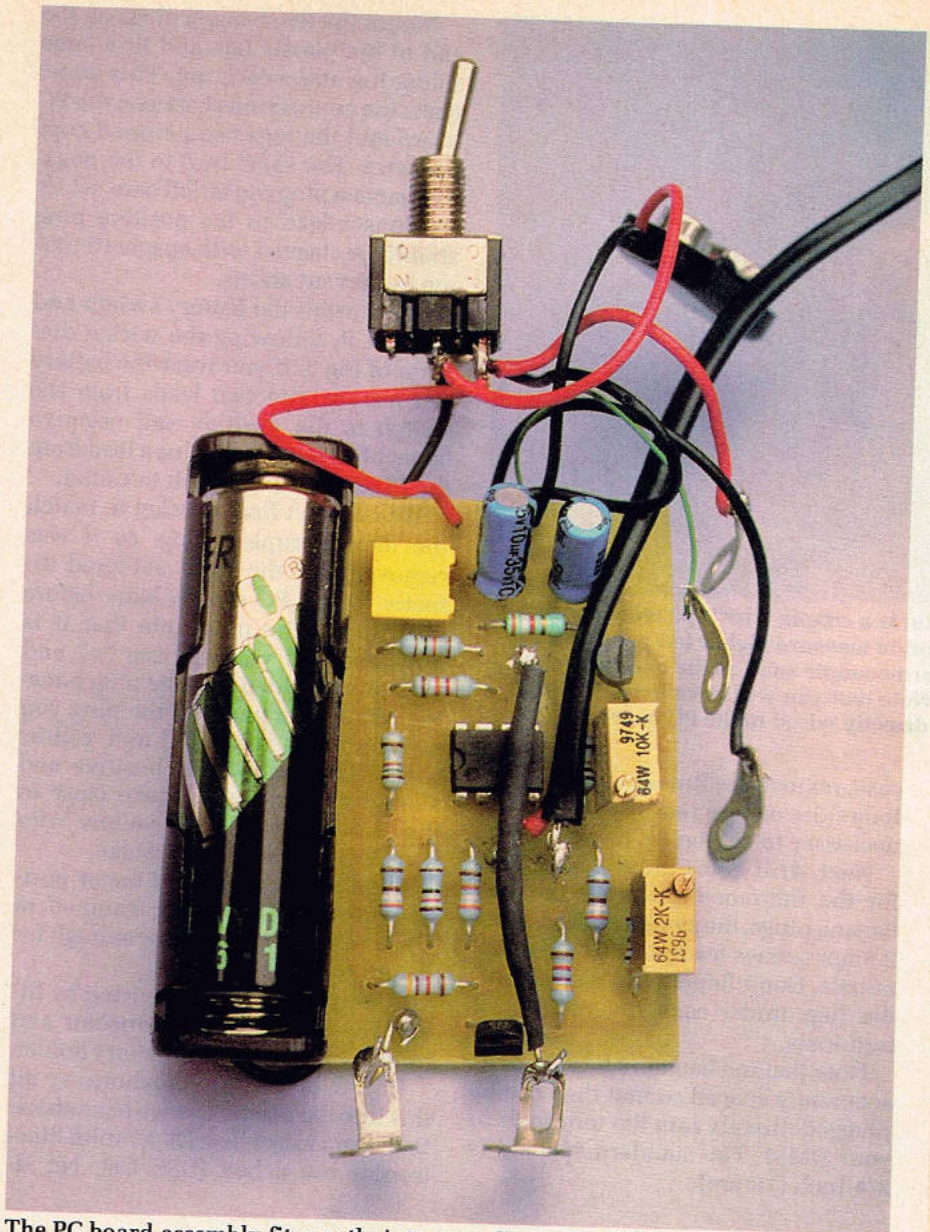
The meter will then show the temperature directly, provided that the gain of IC1 is set to 246.3 (100mV/40.6µV). This gain is set by the 82kΩ, 15kΩ, 390Ω and 12Ω negative feedback resistors. The 3% tolerance on ZD1 won't worry us, as we compensate for this when we set VR2.

The 0.22µF capacitor across the feedback resistors rolls off the gain of IC1 above 7.5Hz. This is done to prevent any hum signals picked up by the thermocouple leads from overloading the circuit.

Power for the circuit is derived from separate 9V and 1.5V batteries. The 9V battery powers most of the circuitry, including the positive supply rail to IC1. The 1.5V battery is included solely to provide the required negative supply rail to the op amp (the op amp won't work without a

Table 2: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	82kΩ	grey red orange brown	grey red black red brown
❑	1	39kΩ	orange white orange brown	orange white black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	2	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	3.9kΩ	orange white red brown	orange white black brown brown
❑	2	390Ω	orange white brown brown	orange white black black brown
❑	2	12Ω	black red black brown	black red black gold brown



The PC board assembly fits neatly into a small standard plastic case. Note the method of mounting the 0.22µF capacitor near the top of the board.

Parts List

1 PC board, code 04111981, 56 x 47mm
1 thermocouple probe
1 plastic case, 83 x 54 x 28mm, Jaycar HB-6015 or equivalent
1 DPST switch (S1)
1 9V battery
1 battery clip to suit
1 1.5V AA cell
1 AA cell holder, Jaycar PH-9203 or equivalent
1 10kΩ multi-turn cermet trimpot (VR1)
1 2kΩ multi-turn cermet trimpot (VR2)
2 banana plugs
2 solder lugs to suit above
4 PC stakes
3 2.5mm x 6mm countersunk head bolts
3 2.5mm nuts
3 solder lugs to suit above
1 3mm x 6mm countersunk head bolt
1 3mm nut

Semiconductors
1 OP07CN op amp, Farnell Cat. 690-624 (IC1)
1 LM335Z temperature sensor (REF1)
1 ZR423 1.25V reference diode, Farnell Cat. 703-412 (ZD1)

Capacitors
2 10µF 16VW PC electrolytic
1 0.22µF MKT polyester

Resistors (0.25W, 1%)

1 100kΩ	2 4.7kΩ
1 82kΩ	1 3.9kΩ
1 39kΩ	2 390Ω
1 10kΩ	2 12Ω

negative supply rail). Double-pole switch S1 switches the power on and off.

Finally, the circuit includes provision to test the batteries under load without opening the case. This is done by connecting the wipers of switch S1 and the 0V rail to three 2.5mm bolts on the side of the case. When the power is switched on, you can easily check the V+ and V- voltages (with respect to GND) using a multimeter.

Construction

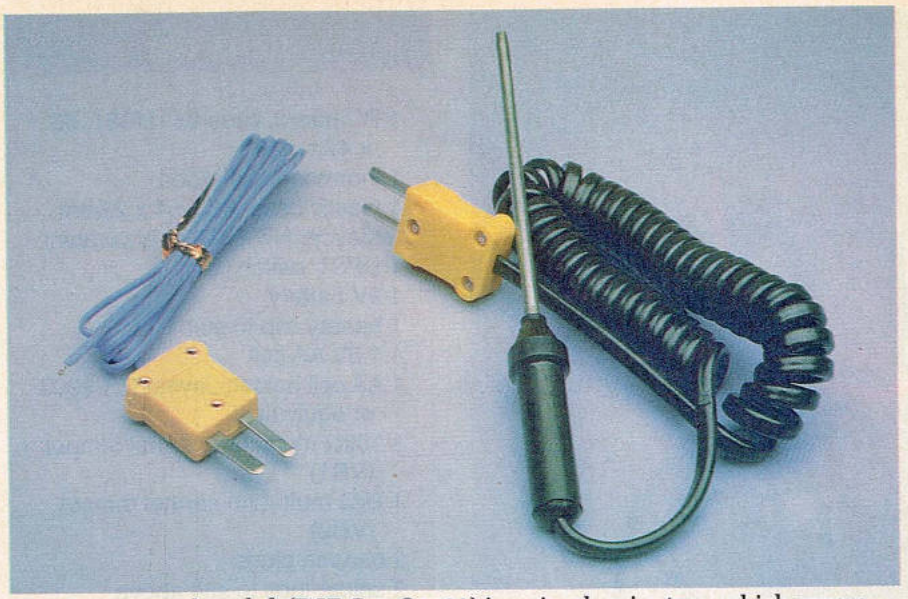
All the parts except for the switch, the meter plugs and the 9V battery are mounted on a small PC board. This is coded 04111981 and measures 56 x 47mm.

Before installing any of the parts, check the board carefully for etching defects by comparing it with the published pattern (Fig.4). It's rare to find any problems but it doesn't hurt to make sure.

Fig.3 shows the parts layout on the PC board. Begin by installing PC stakes at all the external wiring points, then install the resistors. Check each value on your multimeter as you proceed (Table 2 shows the colour codes). Once these are in, the semiconductors and the trimpots can be installed. Make sure that the semiconductors are all oriented correctly and take care to ensure that the trimpots aren't mixed up. VR1 has a value of 10kΩ while VR2 has a value of 2kΩ.

Op amp IC1 should be directly soldered to the PC board. Do not use an IC socket for this device. The reason for this is that it's best to minimise the number of dissimilar metal junctions, as each junction is, in theory, another thermocouple.

The PC board assembly can now be completed by installing the capacitors and the battery snap connector. Note that all the capacitors must be



The thermocouple at left (DSE Cat. Q1439) is a simple wire type which covers the range from -40°C to 250°C. If you want to measure higher temperatures (up to 600°C), you will need a probe type thermocouple such as the one shown at right (Jaycar Cat. QM1282) – see panel. Note that you will have to cut the plug off your thermocouple, so that it can be directly wired to the PC board.

mounted with their bodies flat against the PC board, as shown in Fig.3. This is done to provide clearance for the 9V battery.

The 1.5V battery holder should be secured using a 3mm countersunk screw and nut. You will have to drill a hole through the centre of the holder and the PC board to fit this. Once the assembly is complete, cut the screw off level with the nut so that the battery can be fitted.

Drilling the case

Before you start drilling the plastic case, remove the flutes along both the long sides using a sharp chisel. This is necessary to get the PC board to fit.

Next, drill holes in the plastic box for the thermocouple lead, the two banana plugs, the switch and the three 2.5mm screws for the battery test terminals. Don't forget to fit a small solder lugs under each nut of the test terminals.

Note that the banana plugs must be accurately spaced so that they can be plugged directly into the terminals of your DMM. The standard spacing is 3/4-inch (19mm).

Mount the two banana plugs on the end of the plastic box and fit a large solder lug under each nut. This done, make the connections between the PC board and the lugs using tinned copper wire. The short lead to the negative banana plug can be left bare, while the longer lead to the positive plug should be sleeved with spaghetti tubing to prevent shorts.

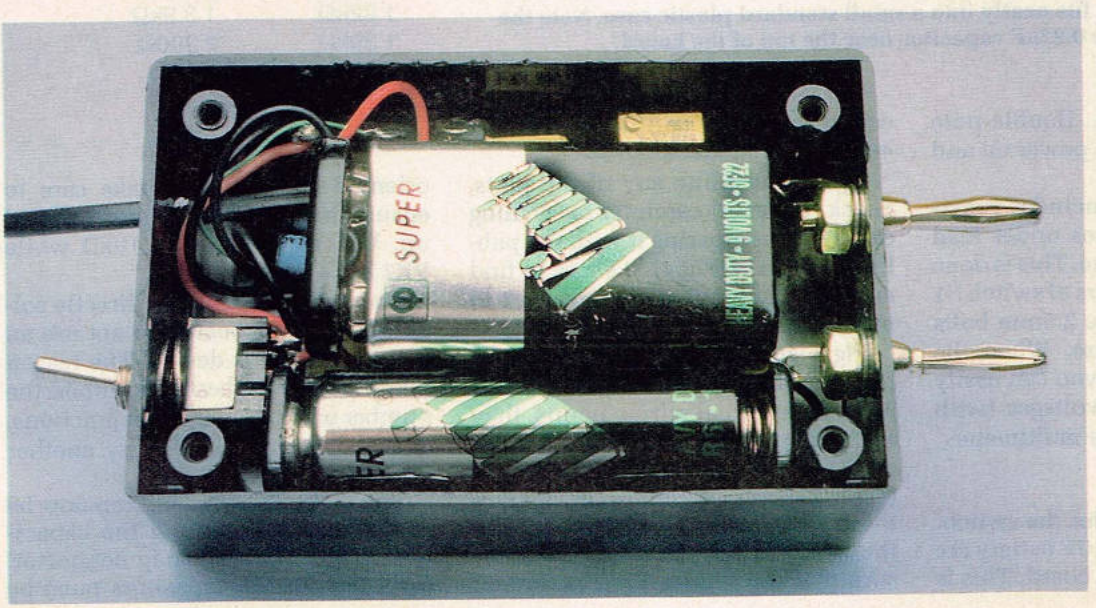
Next install the battery switch and connect it, following the wiring diagram of Fig.3. If you want the battery test feature, run two leads from the switch to the positive and negative battery test terminals, plus a lead from the PC board to the earth terminal.

We couldn't find a socket to match the thermocouple's plug, so it was removed and the leads soldered directly to the PC stakes. Now before you cut off the plug note that it is polarised and you will see "+" and "-" signs moulded into the plug housing. When you unscrew the plug you will find that it has red and yellow wires. The red wire is positive and should connect to PC stake close to pin 3 of IC1 while the yellow wire connects to the other PC stake.

The thermocouple and meter positive stakes will have to be trimmed, to allow the battery to sit low enough for the lid to fit properly.

Finally, complete the wiring by fitting the battery snap connector and running the leads to the battery holder.

If you don't like shoehorning all this into the plastic box we have specified, use a larger box. Dick Smith Electronics has a box (DSE Cat. No H-



It's a tight squeeze when the 9V battery is installed but it all fits. The meter plugs must be spaced so that the unit can be plugged directly into a digital multimeter.

2874) which is 40mm high instead of 28mm and will give you lots more room (but at greater cost).

Calibration

This is the easiest part of the whole project. First, set your DMM to the 10V range and connect it across the two outer terminals of VR1. The best way to do this is to connect the positive meter lead to the end of the 100kΩ resistor that's adjacent to REF1 and the negative lead to a convenient ground point.

Now apply power and allow five minutes for the circuit to stabilise. This done, place an accurate thermometer on REF1, allow it to stabilise and adjust VR1 until the meter reads 2.7312V + (temperature/100). For example, if the temperature is 23°, you adjust VR1 for a reading of 2.7312 + 0.23 = 2.9612V. Of course, if you have a 3.5-digit multimeter, the best you can do is a reading of 2.961V or 2.962V; the resolution that you can attain depends on the number of digits on your multimeter's display.

Now connect your DMM to the METER + and - terminals (ie, to the meter plugs), set it to the 2V range and adjust VR2 for a reading of 0.230V (230mV). This corresponds to a reading of 23.0° which is the same as the reading on the thermometer.

And that's all there is to it; the calibration procedure is complete.

Interpreting readings

If you are using a 3.5-digit meter, the 2V range will cover temperatures from -50°C to 199°C. This should include most of the everyday temperatures you will want to measure. The 20V range will need to be selected to cover temperatures from 200-600°C.

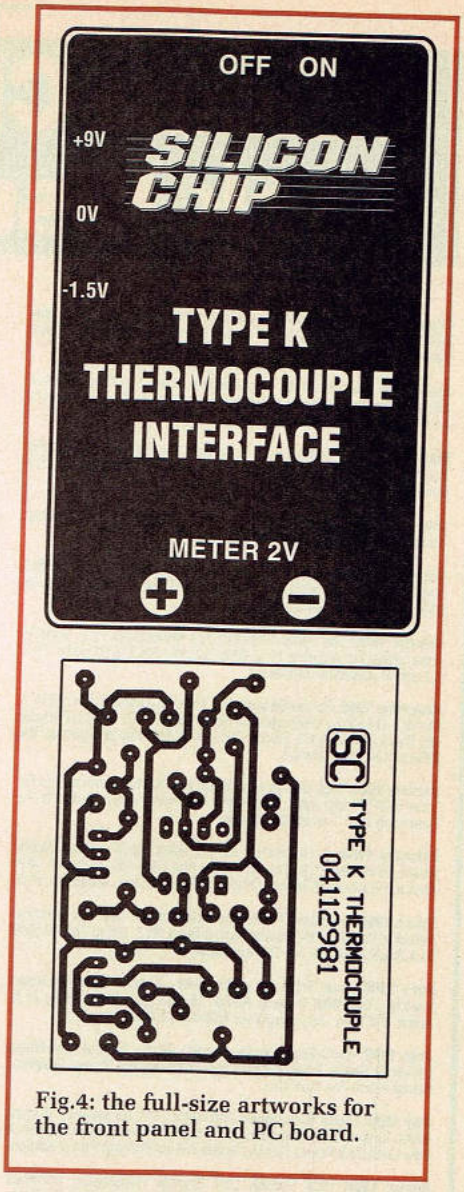


Fig.4: the full-size artworks for the front panel and PC board.

As stated earlier, you must convert the reading on the DMM to millivolts and then divide by 10 to get the temperature in °C. For example:

(1) the meter reading is 4.73V. In this case, 4.73V = 4730mV and so the temperature is 4730/10 = 473°C.

(2) the meter reading is 0.673V. This is equivalent to 673mV and so the temperature is 67.3°C.

Finally, if you plan to use the adaptor to measure temperatures within a specific range (eg, 100-250°C), greater accuracy can be achieved by calibrating the unit at the mean temperature within this range (175°C for the example given). This involves subjecting the probe to this mean temperature and then adjusting VR2 to obtain the correct meter reading. SC

Choosing A Thermocouple

As mentioned in the main body of the text, this project uses a type-K thermocouple. There are several units that are readily available and these are sold by Dick Smith Electronics (DSE) and by Jaycar. These are as follows:

DSE Cat. Q1438: -50°C to 1200°C ($99.95) – probe type
DSE Cat. Q1439: -40°C to 250°C ($19.95) – wire type
Jaycar Cat. QM1282: -40°C to 750°C ($14.95) – probe type

Note: this adaptor can only measure to just above 600°C due to circuit limitations.

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A Regulated 12V DC Plugpack for a Couple of Bucks. . .

As a hobbyist, the chances are you have collected several plugpack power supplies over the years because, well, they're too good to throw away, aren't they? Here's how to turn a surplus plugpack into a fully regulated supply for next to nothing!

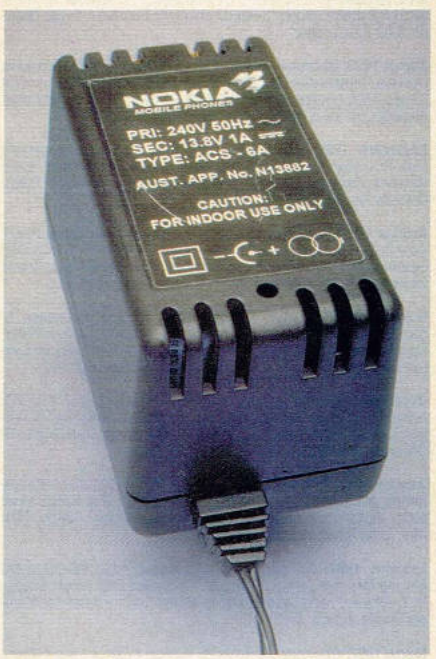
By Ross Tester

First, let's look at these ubiquitous plugpacks. By definition, these are supplies which are designed to hang off a standard 240VAC power point. They come in a wide range of voltage and current ratings; some are AC output and some are DC. They're compact, safe and convenient. But they're not perfect. They have a couple of disadvantages.

For a start, most DC plugpacks suffer badly from hum (or should that read the devices to which they connect can suffer badly...). The reason is simple – they usually only have a bare minimum of filter capacitance for their rated load current.

So while they may be perfectly adequate for many jobs, if you use them to power a small tape deck, DC player or amplifier, hum on their output will be audible – and annoying!

The other major drawback of plugpacks is poor regulation. This means is that there is a wide discrepancy between their open-circuit (ie, no-load) voltage and their full rated load voltage. A typical DC plugpack might be rated at 12V and 1A but when you measure its voltage without a load you're likely to find it is 17V or more.



Here's what we started with: this Nokia plugpack from Oatley Electronics is rated at 13.8V 1A but measured over 17V no-load. Poor regulation is typical of plugpacks, as is an excess of hum in the DC output.

Sure, when it's supplying the rated current the output might fall to nearly 12V but most electronic devices don't draw their full rated current all the time. So the supply voltage could be varying all over the shop.

Making the situation worse is the input voltage. While the mains voltage is a nominal 240VAC it can vary quite widely. Here at the SILICON CHIP office it seldom falls below 252-253V. One of our staff members regularly cops 260V (he's at the top end of a very long power feeder). My house, only a few kilometres away, averages about 243VAC.

The problem is that if the mains voltage is high, so will be the output of the plugpack. Combine this with poor regulation and a plugpack rated at 12V DC could easily deliver more than 18V if the mains voltage is high!

Aren't most devices designed to cope with variations in input voltage?

Well, yes and no. But feeding more than 17V to a device calling for 12V DC can be risky; you could blow it up. As a matter of fact, if you have a switchable plugpack with outputs of say 6V, 9V and 12V, it is generally better to switch it to 9V when powering something calling for 12V; it is better to be safe than sorry.

But wouldn't it be better still to have a 12V plugpack which delivered a genuine 12V DC all the time, regardless of the load current and input mains voltage? And wouldn't it be better again if it had very low hum output? You can achieve this fairly easily by putting a regulator circuit inside the plugpack itself. This can be done with the good old garden-variety 78xx 3-terminal regulator.

There are a couple of wrinkles one has to take into account – for example, the 78xx series of regulators in TO-220 cases all need an input voltage about 2.5V above their rated output voltage to regulate properly. But under normal circumstances they're almost indestructible - overloading/overheating and even shorting will simply cause them to shut down.

The regulated plugpack

You can presently buy a regulated plugpack without too much drama. But they're not cheap - at least thirty dollars or so and typically about ten dollars dearer than an equivalent unregulated model.

But this article is intended for those who have a plugpack or two lying around – possibly once connected to something which has failed but you've kept the plugpack.

For the cost of a regulator (less than $1.50), a small capacitor (no more than 50c if you have to buy one) and perhaps a LED and resistor (another 50c or less) you can turn that plugpack into a regulated supply in an hour or less. Note that we are not talking about piddly little 200mA or even 500mA plugpacks – there isn't a great deal of room in them at the best of times. No, this article is aimed at the larger plugpacks, typically rated at 1A or 1.5A. Usually these plugpacks have enough space inside the case and also have benefit of a larger filter capacitor into the bargain.

What we are going to do here is show you how to get the plugpack case open without destroying it, fit the extra components required and close it up again.

Before we start though, a word on legalities: to be sold in Australia, plugpacks must be type-approved – that is, they must meet certain standards on safety (mainly insulation) and construction. Opening the case of the supply will almost certainly void that type approval; fitting new components

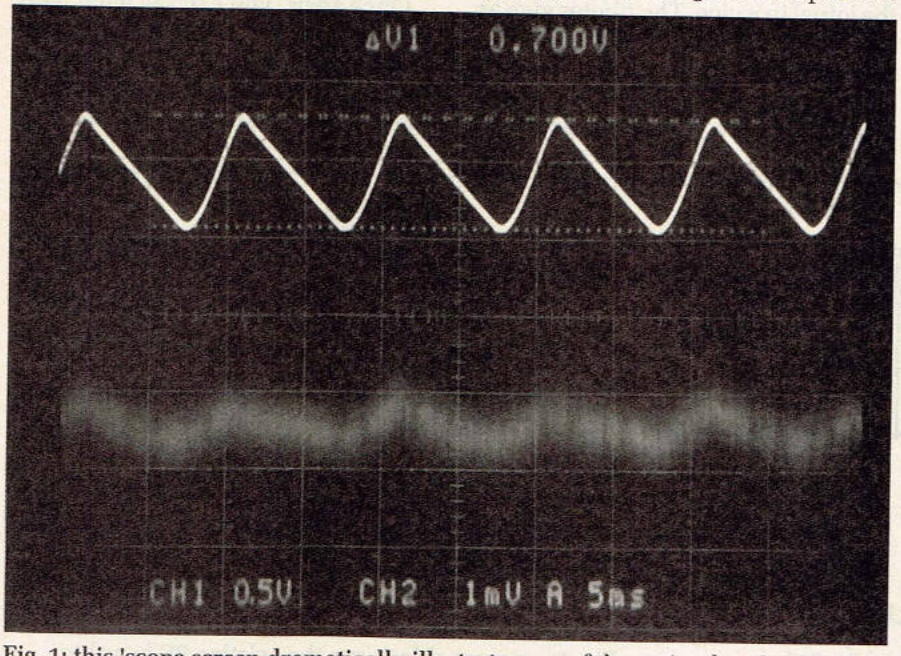
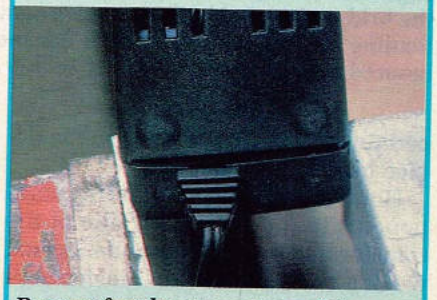


Fig. 1: this 'scope screen dramatically illustrates one of the major drawbacks of plug-packs: hum. The top trace shows the plugpack supply output before modification with severe 100Hz hum – 700mV peak-to-peak. This would play havoc with an amplifier. The bottom trace shows the output after the regulator with just 1.5mV pk-pk of hum and noise . The load in both cases was 600mA.

OPENING UP THE WELDED PLASTIC CASE

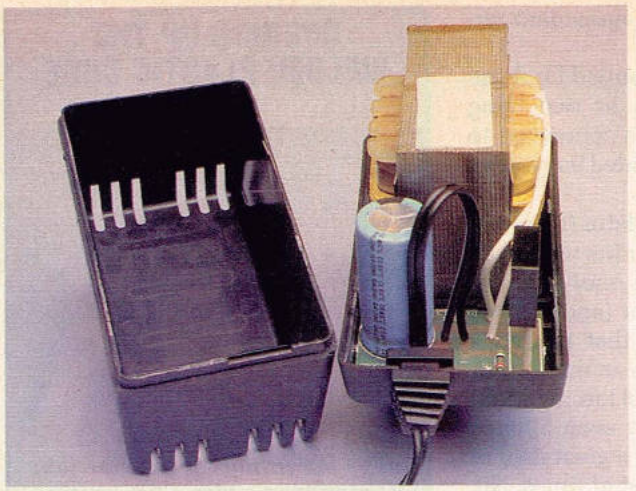
Gently but firmly squeeze the join just nipped in a vice. Tap gently with a ball peen hammer as you tighten the vice.



Repeat for the opposite end then the sides. Here you can see the join just opening up under the pressure.

Once the join is cracked, a flat blade such as a table knife will help break the weld.

Finally, lever the two halves apart out of the vice, again using the knife (or even two knives).



This is what we found when the case was opened: a 6A bridge rectifier and, importantly, a nice, big smoothing capacitor (4700µF). The 3.9kΩ resistor just visible under the bridge is probably there to give some minimum loading but it is redundant after our mods. We've ignored it for the sake of clarity in this article.

certainly will, if only because the device hasn't been tested.

However, we are only adding components to the secondary side of the transformer, not the bitey side. In fact, we don't even touch the transformer - it stays locked into place exactly where the manufacturer put it.

Getting started

As Mrs Beaton's cook book states, first catch your hare, or in this case, your plugpack. What you need is one nominally rated a bit over 12V DC (13.8V is common; up to 15V DC is OK) rated at 1A or 1.5A; anything larger and the transformer will probably take up too much space.

We did mention before that the regulator needs an input 2.5V higher than the rated output yet we're using a supply rated at 13.8V. Yes, we know that 12 + 2.5 doesn't equal 13.8 but we are relying on the poor regulation of the plugpack. The output voltage will normally be somewhat higher than 14.5V (in fact, ours measured 17.3V with no load and a 240VAC input).

The surgery

The first step is to open the welded plastic case. These cases are made in two halves, one of which fits into a recess in the other. When assembled, they are welded (very occasionally glued) together. What we have to do is break that weld (or glue) without destroying the case.

Fortunately, this is fairly easy to do once you know the trick which is to apply just enough pressure to make the weld crack open. We do this by gently squeezing the joins (and just the joins) in a vice. The photos give an indication of how it is placed.

Start with the shorter sides as these are easiest to handle. Place the plugpack in the vice using some jaw protectors (to prevent damage to the case surface) and tighten the handle up to a firm but not tight grip.

Each time you slightly tighten the vice grip (no more than about a tenth of a turn at a time) *gently* tap the join with, say, a ball peen hammer. Before too long, you should hear a reassuring "crack" as the weld gives way.

Repeat this for the opposite end, then for the two longer sides. What happens next depends on how lucky you have been. Sometimes you'll find the two halves of the case can be pulled apart at this stage but more likely than not you'll need to gently prise apart the two halves.

A wide, flat bladed knife such as a kitchen or table knife is best. Anything smaller, such as a screwdriver, is likely to mar or even tear the case and you don't want that. Once you've been able to get one or two knives between the case halves you should be able to gradually work around the case, prising it apart as you go. If all the welds have been cracked, it normally doesn't take too much effort to separate the halves.

Sometimes some of the plastic in the join breaks instead of the weld. If not too much, this is not too serious because you will be gluing it all back together anyway.

The transplant

Once apart, you can see what work you have to do to include the new components. Again if luck is with you, you will find a PC board which can be slightly modified. However, we have

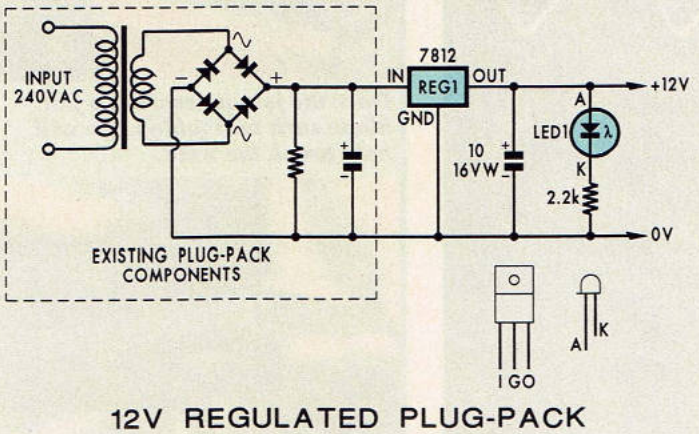


Fig. 3: the circuit of the retro-fitted plugpack. Only four extra components are needed and these all mount within the existing plugpack. The most difficult part is getting the case apart!

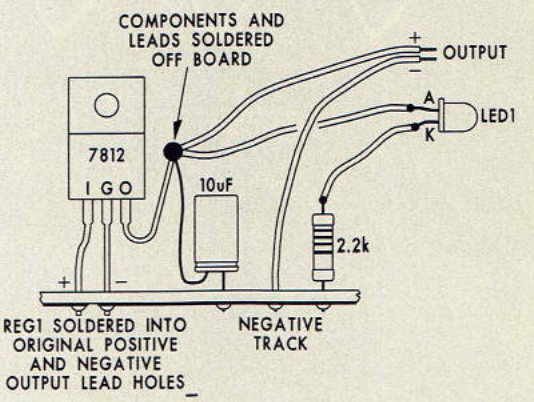


Fig. 4: we were able to use the existing PC board to mount some of our components. If you think soldering components in mid-air is not ideal, you're right – but some plugpacks are made *entirely* this way!

seen some plugpacks where the components are simply soldered to each other. The modifications are then not quite as simple but possible nonetheless.

Inside most plugpacks, all you will find is a rectifier and a filter capacitor. The rectifier could be either a four-terminal bridge or it could be four individual diodes forming a bridge. Very occasionally, you'll find a centre-tapped transformer has been used with two diodes in full-wave centre tapped configuration.

Regardless of the type, we don't have to modify the rectifier in any way. Following the rectifier will normally be an electrolytic filter capacitor. In our plugpack there was also a 3.9kΩ resistor but this can be ignored because its effect is minimal.

In the case we pulled apart for this article, we were delighted to find a 4700µF 25V type which provides a good level of filtering. In some plugpacks, though, we've found capacitors as small as 470µF – barely adequate and voltage ratings down to 16V – certainly inadequate.

16V is sailing very close to the wind, with the capacitor operating right on (or more likely slightly over) its limits. It has no margin for safety – for example, to handle any voltage spikes. If you find a low value, low voltage capacitor it is be a good idea to replace it (if possible) with a more suitable type. At a minimum, we would suggest 2200µF 25VW; anything larger is a bonus if it will fit. (There's no point in fitting one with a high voltage rating; all else being equal, go for increased capacitance).

Parts List

1 Plugpack power supply rated approx 13.8-15VDC @ 1A

1 7812 positive voltage regulator

1 5mm LED, any type

1 10µF 16VW electroyltic capacitor

1 2.2kΩ 1/4W resistor

Speaking of space, some of that is going to be needed for the regulator and one or two other components we haven't mentioned yet. First of all, we need to put a small electrolytic capacitor across the output of the regulator to make sure that it does not oscillate supersonically.

Secondly, the regulator doesn't like being left unloaded – it needs a small output current at all times. One way to do this is simply place a resistor across the output to draw a few milliamps at all times. 2.2kΩ will give us about 5mA. But if we're going to throw away a few milliamps, why not feed it through a LED which will also give us a power on indicator.

Gilding the lily? Perhaps – but there was a convenient hole in the case for the LED and LEDs cost only 30 cents, so why not!

Fitting it all in

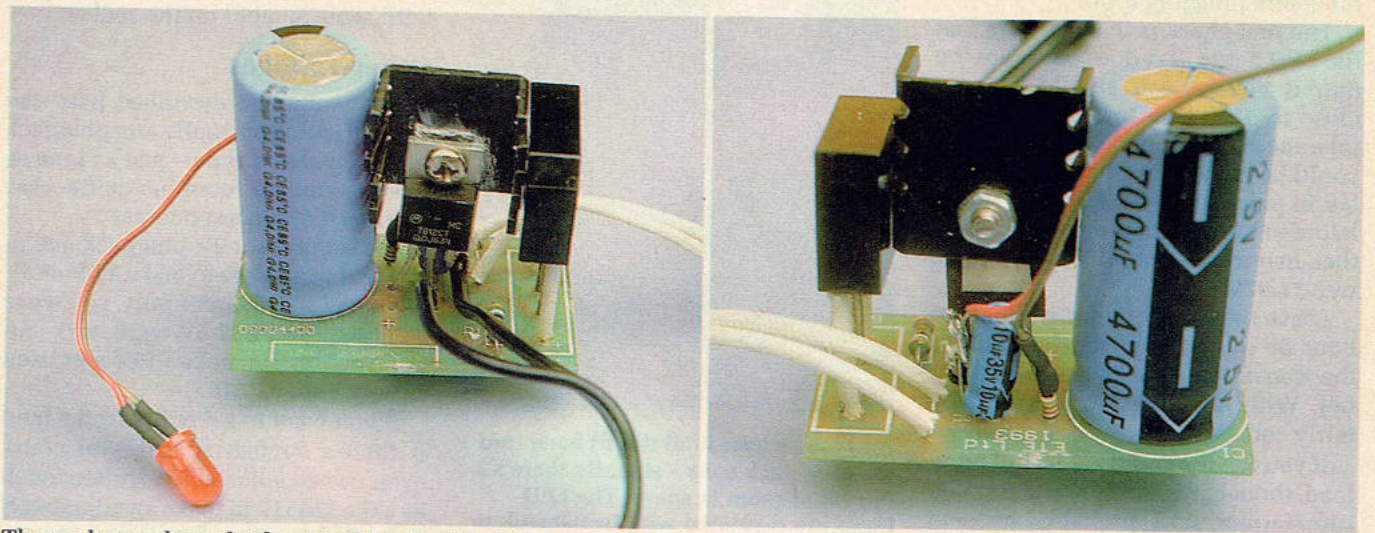
Your next step, as was ours, is to decide how to mount the regulator, capacitor and resistor for the LED (the LED itself was on the case top, connected by two strands of rainbow cable).

The 3-terminal regulator is mounted effectively in series with the output of the plugpack. We already had two holes in the PC board for the output leads – plus and minus. Removing the output leads gave us two of the three mounting points we needed for the regulator – input and ground. It was a simple matter to drill a new hole on the negative supply track of the PC board for the negative output lead.

The output terminal of the regulator and with it the connection of the positive output lead, the positive side of the extra capacitor and connection for the LED proved to be not quite so simple. So we cheated a bit. Instead of trying to mount all of the above on the PC board, we bent the output lead of the regulator back up through 180 degrees and used this as a terminal point.

The extra 10µF capacitor across the output was mounted with its negative lead going through a hole drilled into a suitably close point on the negative track and the positive lead was bent back up the capacitor body and soldered to the regulator output lead. These two leads were rigid so they stayed in position to solder.

The other connections, the output positive lead and the positive going to the LED were first twisted together and soldered to make them easier to solder to the regulator output. We've already mentioned that we drilled two new holes in the negative track for the negative output lead connection and



These photos show the front and back of the PC board after the new components were added. Exact placement isn't too important – as long as everything fits and the assembled board fits back in the case. We were lucky – there was just enough room between the bridge rectifier (black component on board edge) and the main filter electrolytic capacitor.

negative end of the 10µF capacitor. We also drilled a new hole in the same track for the 2.2kΩ resistor to stand end-on, with the other pair of the rainbow cable leads to the LED soldered to the top of this resistor.

There probably won't be a hole in your case for the LED – this will have to be drilled. If you're careful with the size you can make the LED a tight fit in the hole. A tiny drop of super glue will then hold the LED in place.

Where there was any danger of flying leads coming off - eg, on the LED, and the top of the resistor – we covered them with short lengths of heatshrink sleeving.

Last of all, we fitted a small U-shaped heatsink to the regulator, using a small amount of heatsink compound to improve thermal conductivity. There is no need to use insulating washers or bushes unless there is any danger of the heatsink contacting anything else.

That brings us to the final check – making sure that nothing is touching anything that it shouldn't be and that nothing will be pushed out of position when the two halves of the case are recombined.

If there is any danger of this happening, fit insulation between the offending components.

Testing it

It is quite safe to plug in the supply without assembling the case because the transformer completely shields the 240VAC connections.

Nevertheless, turn the power point off before plugging it in.

The first check is to make sure that the LED lights. If it does, measure the output voltage – it should be very close to 12V. Due to manufacturing tolerances, the actual output voltage could be anywhere from 11.5 to 12.5 but in practice, we've found the regulators to be much more accurate than that. In our case, actual output voltage was 11.97V.

Leave the supply on for, say, half an hour or so and confirm that neither the transformer nor the regulator get hot. With no load they should stay fairly cool.

If you run the supply at its full rated load, though, it's a different story. The transformer will probably become quite hot to touch and the regulator/heatsink may well be bordering on the too-hot-to-be-held.

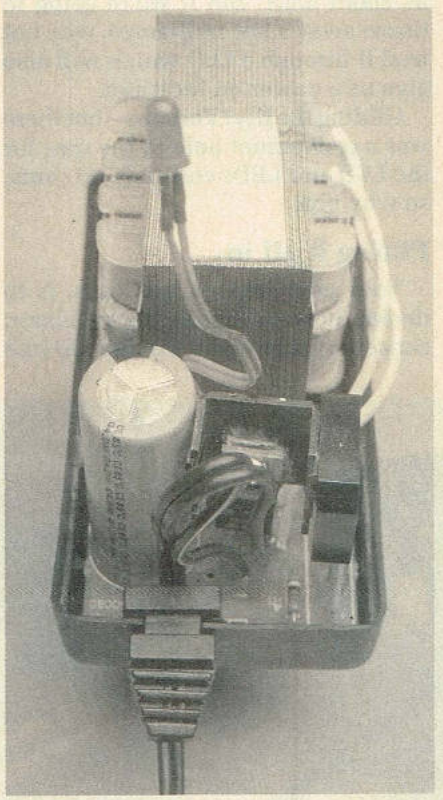
This front panel artwork fits the case recess on the Oatley (Nokia) plugpack and may be adaptable to other models.

Putting it back together

If everything checks out OK, it's time to put the case back together. First, make sure that none of the cables protrude from the case and any captive cord anchor on the output cable fits back into its appropriate slot.

Push the two halves of the case together just to make sure it all goes back together and then pull them apart slightly, ready for gluing. Which glue? It doesn't really matter as long as the glue is made to adhere to plastics. We've found a few drops of super glue placed judiciously around the seam work very well and it has the advantage of drying very quickly.

And that's just about all there is to it. All up, it should only take an hour or so from beginning to end.



And here's how it all did fit back into the plug-pack case – actually there's a fair bit of room to spare. The LED leads are insulated with heatshrink to make sure they don't short to each other or to anything else when the case is assembled.

Plug polarity

Unless you fluked a plugpack with a plug already fitted you will need to solder a DC power plug onto the end of the lead. Naturally, you should use the plug which suits the equipment you're going to power. There is a wide variety of plugs used but if you have the choice you should aim for one of the larger variety – after all, the supply can pass 1A or more on peaks.

As far as polarity is concerned, there is a standard: whatever the manufacturer decided on that particular day. Originally it was intended that the centre of the DC plug be the positive and the outside the negative (just the same as the tip on a 3.5mm or 6.5mm jack plug is positive, body negative).

Unfortunately, this standard has gone out the window so now you have to fit the plug to suit. Some plugpacks have a polarity reversing plug and socket moulded into the cable – if this is the case make the centre positive when the symbol on the reversing plug (+, - or o are often used) is lined up with same symbol on the socket.

Other voltages

The technique described here can be used to turn virtually any plugpack into a regulated type – just as long as there is enough room inside the case to fit the extra components.

For example, a 9V plugpack makes an ideal candidate to make a 6V or 5V regulated supply (naturally, you'd use a 7806 6V or 7805 5V regulator). An 18V version can make a 15V regulated supply with a 7815.

If you want to get really tricky (and if there's enough space), you could even use an adjustable regulator such as a the LM317 to make an adjustable, regulated supply. You'll find the circuit on the SILICON CHIP web site – www.siliconchip.com.au SC

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Plug it into computer games, stereos etc, then put the back pack on and feel all the low frequency sounds. See 98 Cat. page 213 for full details.

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$11.95

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WAS $249

JAYCAR JC50 10" 3 WAY SPEAKER KIT

NEW

Ref: Electronics Aust. Dec. 1998. Enjoy the full and rich sound of a sophisticated three way speaker system by putting it together yourself and save hundreds of dollars in the process.

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The JC50 uses a 10" Re/sponse woofer, with a Re/sponse dome midrange and Vifa D19 dome tweeter. The power handling is 120W RMS / channel, and the cabinet size is 845(H)x300(D)x295(W)mm. The cabinets are pre-built in MDF with all holes cut, and finished in black-grey oak. The cross-overs are prebuilt, so all you need to do is solder the leads, and mount the drivers etc. You will need a soldering iron, a drill and a screwdriver.

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Use bracket or spike for different mounting positions. Size 100(H) x 96 Dia. mm. excluding bracket and spike.
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Use a narrow beam halogen globe for high- lighting. Includes a hood which can be rotated. 320mm approx. length, dia. at globe 65mm.
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MR16 ROUND WITH BUILT REFLECTOR TO SUIT:
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See our 1998 Catalogue for full details.
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Consists of 32 odd driver bits:
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Ref: SC Nov 98

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*Charger now supplied with AA charging plate also.

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See 98 Cat. P 64.

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Main unit will support up to three main sensors, with high/low alarm for each, min./max. reading (-5°C to 50°C). Remote sensors are splash proof, have their own display, and can transmit up to 30m. The main unit is supplied with one sensor.

WIRELESS IN/OUT THERMOMETER Cat. QM-7220 **$119**

EXTRA REMOTE SENSORS Cat. QM-7221 **$49**

8" 24 HOUR WALL CLOCK

Great for shift workers! Quartz timing with white face (Dia. 20cm) and black numbering. Cat. XC-0111 **$19.95**

10" CLOCK WITH HUMIDITY & TEMPERATURE

Quartz timing with black face (20cm dia.)and white numbering. Cat. XC-0112 **$19.95**

6500 8 SECTOR ALARM SYSTEM

SAVE $$$

The economical way to buy a top quality, low priced system. Includes all the components to give you and your family peace of mind. See page 77 of '98 Catalogue for full details. Cat. LA-5444

only $299

ANOTHER SCOOP PURCHASE!

HIGH TORQUE DC MOTOR

This powerful compact motor will provide good torque on supply voltages from 12-30V. It will reach maximum efficiency at 24V with a torque load of 60g.cm and draw 310mA @ 8350rpm. Efficiency is almost 70%! The hardened steel drive-shaft is 2.3mm (3/32") dia. x 2.7mm (1/2") long. Sturdy sintered bronze shaft-bearings ensure long life. Mounting is effected with 2 x M2.6 threaded holes on the front face of the motor. Two suitable screws are included with the unit along with a full data sheet on the motor's performance characteristics. This is not a "toy" motor. It is designed to give daily performance for hours at a time. You will be delighted with this product. Cat. YM-2709

$3.95ea or 10+ $3.50ea

TAPERED REAMER

This great new tool is ideal for enlarging and shaping holes in plastic, thin metal and wood. Tapers from 3mm to 12mm and is made from high quality treated steel.

Cat. TD-2130 **$12.50**

HEADSET TELEPHONE

This is a stand alone headset telephone, not a hands-free adaptor. The headset and mic boom are fully adjustable and the ear piece has comfortable padding. It is not suitable for Commander systems. Cat. YT-7060

$69.95

AMPLIFIED WALKMAN SPEAKERS

Plugs directly into the headphone socket and features gold connectors, individual volume, treble boost and dynamic base boost controls. Requires 4 x 'C' size batteries or 6 VDC plug pack. Size 155(H)x95(W)x90(D) mm (ea). 24 watts (12 watts PMPO) Cat. CS-2425

Normal Price would be $49.95 Pr

Only $37.95 Pr

MINI MULTIMEDIA COMPUTER SPEAKERS

Features: Gold audio plug, 16 watt PMPO per speaker with bass boost switch and volume control. Fully shielded and will operate from either 4 x 'C' size batteries or the plug pack which is included. Size 135(H)x84(W)x92(D) mm. Cat. XC-5163

Normal Price would be $55 Pr

Only $39.95 Pair

Plug Pack Supplied

LARGE MULTIMEDIA COMPUTER SPEAKERS

Fully shielded 36 watts PMPO per speaker. Speakers supplied with 1.2 amp, 9 volt plugpack. Size 170(H) x 104(W) x 118(D) mm. Cat. XC-5164

Normal Price would be $79.95 Pair

Only $59.95 Pr

Plug Pack Supplied

JUMBO MULTIMEDIA COMPUTER SPEAKERS

These speakers will produce 120 watts PMPO per speaker of quality sound, fully shielded with individual base and volume controls, 3.5mm stereo headphones and microphone jacks. Supplied with a massive 2.5A, 12VDC power supply worth around $40 on its own! Size 213(H) x 123(W) x 128(D) mm. Cat. XC-5165

Normal Price would be $129 Pr

Only $99.95 Pair

Power Supply Supplied

BUY 5 OF A PRODUCT WORTH $100 OR MORE LESS 10%

MAIL ORDER - FREECALL FOR PHONE ORDERS 1800 022 888

3.6V COMPUTER LITHIUM BATTERY

As used in PC's.

Cat. SB-2540 **$11.95**

6, 9, 12V DC 1 AMP REGULATED POWER SUPPLY

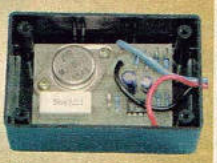
Cat. MP-3032
Was $42.95 Save $10
December $32.95

EXTREMELY LARGE DIGITAL CLOCK WITH TEMPERATURE HUMIDITY & CALENDAR

Ideal for office, factories, homes, wine cellars etc. Includes:
- Humidity sensor
- Temperature in °C and °F
- Calendar with day, date and month
- Huge display 146(w) x 95(H)
- Overall size 210(W) x 210(H) x 25(D)mm. Cream and silver in colour, operates on 2 AA batteries (not supplied) Cat. XC-0232

Was $99.95 Save $10
Xmas $89.95

ENGINE IMMOBILISER KIT



See 98 Cat. P11.
Cat. KC-5196
Was $24.95
December $20
Save $4.95

BARGAIN CD-R's

JAYCAR BLUE or BLUE - BULK

Supplied in jewel case	Supplied in bulk pack of 10. No cases.
Cat. XC-4712	Cat. XC-4714
$2.95 or 10 for $26.50 100 for $250	Pkt 10 $25.95 10 Pkts (100 CD's) $233.60

PHILIPS GREEN RICOH GOLD

Supplied in jewel case	Supplied in jewel case
Cat. XC-4711	Cat. XC-4710
$3.50 or 10 for $29.50	$4.50 or 10 for $37.50

FREE CHRISSY PRESENT WITH EVERY DURATECH SOLDER STATION IN DECEMBER

Buy This

Buy our new soldering station in December and we'll give you a 1 Kg roll of .71mm solder for Christmas for free. Value $26.95.

Get this Free!!

Cat. TS-1380

Cat. NS-3002

TEMPERATURE ADJUSTABLE SOLDERING IRON BARGAIN

Grab a spare at this silly price! Adjust from 250°-450°. 30 watt ratio. Cat. TS-1460

Normally $49.95

Now $37.95 Save $12

3.5" DISKS

BLACK DISKS Now $11.95
Pkt 25
Cat. XC-4740

COLOURED DISKS Now $12.95
Pkt 25 Cat. XC-4742

CAR ALARM MADNESS

Install one during the holidays, and save money! Alarms include: Control box, 2 key fob transmitters, ignition cut out relay, shock sensor, LED for dash, wiring harness.

2 models available.
See 98 Cat. page 74 for full details and features.

WITH SIREN
Cat. LA-8912 **Only $149.50**
Was $179.50 Save $30

WITH BACKUP BATTERY SIREN
Cat. LA-8914 **Only $169.50**
Was $199.50 Save $30

SIREN BACK UP SIREN

MAGNIFIER ON FLEXIBLE STAND

The powerful 62mm magnifying lens is mounted to a flexible 150mm long stand and is perfect for when you need to work with both hands free.

NEW ITEM

Cat. QM-3530

$19.95

LOWER PRICES ON AA NICADS

1000MAH

Type	Cat	Save	Were	NOW
Nipple	SB-2440	$1.00	$4.75	$3.75ea
Solder	SB-2441	$1.00	$4.95	$3.95ea

800MAH SELLOUT PRICE

Type	Cat	Save	Were	NOW
Solder	SB-2451	$1.00	$3.75	$2.75ea

LIMITED QUANTITY AVAILABLE

MEGA BRIGHT LEDS REDUCED

These LEDs are so bright, its hard to believe they are LEDs. All are 5mm and are water clear.

Colour	MCD	V	Cat	Were	NOW
Red	6500	1.9	ZD-1772	$3.95	$2.95
Yellow	9300	2.2	ZD-1773	$3.95	$2.95
Green	6000	3.5	ZD-1774	$12.95	$9.95
White	3000	3.5	ZD-1775	$12.95	$9.95
Blue	3000	3.5	ZD-1776	$12.95	$9.95

Buy 10 mixed for 10% off!

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www.jaycar.com.au

PRO VIDEO PROCESSOR WITH ENHANCER MIXER

See catalogue page 189 for full details. Cat. AV-6415

ONLY $149.50

FREE POWER SUPPLY WORTH $22.95

4 DOOR CENTRAL LOCKING KIT

Includes 2 masters, 2 slaves and the controller relay. Beware of low quality kits!! Cat. LR-8830

DEC $59 Save $16

VULKAN FOR CHRISTMAS

VULKAN PROFESSIONAL

Buy yourself that new gas soldering iron for Christmas.

Normally $89
XMAS $69
Save $20 Cat. TS-1200

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Only available by ordering from our Mail Order Department direct.
NOT AVAILABLE AT OUR RETAIL OUTLETS
Call 1800 022 888 & have your credit card handy!

•Cat GG-1065 **Equator Car Alarm**. Repaired unit, but otherwise virtually new. Sold in 96 as Cat. LA-8902 for $189 without siren. 90 day warranty. Qty 14. **$85 without siren**

•Cat GG-1066 **Equator Car Alarm**. Repaired unit, but otherwise virtually new. Sold in 1996 as Cat. LA-8905 for $229 without siren. This unit has all the features of the GG-1065 but with the addition of super code protection, anti code grabbing and anti scanning. See Jaycar Catalogue 1996, P157 for details 90 day warranty. Qty 21. **$110 without siren**

GG-1065

•Cat GG-1067 **Krone Part #6450-2.** 19" Recessed Back mount Frame, 3 Rack unit, Austel approved. All polished stainless steel. Brand new in boxes. Qty 12. **$35**

GG-1067

Limited quantities available on these products. Be Quick!!! All stock brand new unless stated.

NEW JAYCAR KITS

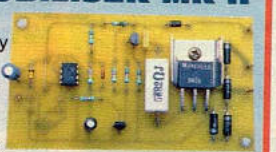
THERMOCOUPLE ADAPTOR FOR DMMs

REFER: SC DEC 98. Measures temperature using your digital multimeter. This kit plugs into your DMM & allows you to measure temperatures between -50°C to 600°C using a 'K' type thermo-couple probe. Housed in a small plastic case and powered from regular 9V and AA batteries, this kit is extremely portable. Kit supplied with case, PCB, 'K' type thermocouple, batteries and all electronic components.

Cat. KC-5256 **$34.95**

ENGINE IMMOBILISER MK II

REFER SC DEC 98



This immobiliser repeatedly stalls the engine when a thief tries to start your car. The circuit allows the engine to start, but will stall the engine after about two seconds, giving them the impression that there is an intermittent problem. They should then move on to another car. An add-on project in the January Silicon Chip will allow keypad connection for disable, along with other features. Kit supplied with PCB, plastic enclosure and all specified electronic components.

Cat. KC-5255 **$29.95**

CELLULAR PHONE BATTERIES SLASHED

ALL ARE NI-MH (except SB-2572)

TYPE	CAT	NOW	WAS	SAVE
Nokia 1610 1.2A	SB-2552	$35.00	$49.50	$14.50
Nokia 3110/3810 1.2A	SB-2553	$35.00	$49.50	$14.50
Nokia 5110 0.95A	SB-2554	$45.00	$59.50	$14.50
Nokia 101/121 1.2A	SB-2555	$39.95	$49.95	$10.00
Motorola Tac Slim 0.9A	SB-2569	$59.50	$69.50	$10.00
Motorola Tac 2.1A	SB-2571	$59.95	$79.95	$20.00
Motorola Tac Li-ion 1.35A	SB-2572	$79.00	$99.00	$20.00
Ericsson 628/688 1.2A	SB-2576	$35.00	$49.50	$14.50
Ericsson 788 0.6A	SB-2577	$35.00	$49.50	$14.50
NEC P3 1.2A	SB-2581	$35.00	$49.50	$14.50
NEC Fido 1.2A	SB-2582	$35.00	$49.50	$14.50
NEC Sportz 1.2A	SB-2583	$29.95	$39.95	$10.00
Philips Fizz 1.8A	SB-2590	$49.95	$69.95	$20.00

12V ACTIVE COLOUR ANTENNA UHF / VHF / FM

IDEAL FOR CARAVANS, CARS, CAMPING AND HOUSES WITHOUT 240VAC MAINS! The antenna contains a built-in amplifier that operates from 12VDC. It can be powered from the vehicle's battery and/or use it at home with the optional AC mains adaptor. (MP-3002 $12.95). The antenna has telescopic dipoles at the rear for fine-tuning your reception, while the amplifier has a built-in splitter for a second TV antenna, a 6 metre coaxial lead with plugs, and a 12V power lead. Specifications: •Gain 22-24dB •Power source: 12VDC, 100mA •Antenna size: 340(W) x 375(L) x 55(D)mm.

Cat. LT-3170 **$59.95**

NEW MEM

SAVE MONEY ON CHRISTMAS PRESENTS FROM JAYCAR

EASY START CAR JUMP CHARGER

See Cat P85. Cat MB-3595
Was $39.95
Xmas $20
Save $19.95

240V WIND UP EXTENSION REEL

12.5 Mtr. long, circuit breaker, 2 sockets. Cat. PS-4135
Was $39.95
Xmas $20
Save $19.95

JOYSTICK

2 button, suits IBM 286-486. Cat. XC-5156
Was $24.95
Xmas $20
Save $4.95

10 DIGIT TALKING CALCULATOR

Cat. QM-7276
Was $29.95
Xmas $16
Save $13.95

8 DIGIT TALKING CALCULATOR

Cat. QM-7275
Was $24.95
Xmas $12
Save $12.95

5 MTR PRO OFC LEAD

Double sheilded with metal plugs and centre lead. Cat. WA-1094
Was $34.95
Xmas $20
Save $14.95

Military Gas Torch

This Pocke Torch lighter runs on butane gas. The case is clear and it has a piezo start. The flame is adjustable and can be locked off or on. Supplied with a cap on a chain. Height with cap is 76mm. Cat. TS-1684
Only $29.95

NEW MEM

MOBILE BABY MINDER

IDEAL CHRISSIE PRESENTS

The transmitter (in the baby's room) plugs into the mains power & transmits to the receiver which is mobile. So you can take it with you outside & still monitor the baby. Cat. AI-5540
$62.95

NEW MEM

QUICK CONNECT PACK

Includes 160 pieces in a handy case. Cat. PT-4530
ONLY $16.95

SMOKE DETECTOR

Protect your family! Buy them one each for Xmas! Cat. LA-5090
Normally $12.95
Only $10

ILLUMINATED MAGNIFYING LAMP

Mains powered lamp, with 22 watt circular fluro. Magnifier is a 3 diopter lens. Colour is white. See Cat. P185 for details. Cat. QM-3525
Was $149.50
Dec. $125
Save $24.50

DOOR ENTRY CHIME

Put it on a door or window to announce a visitor. Great for offices, shops etc.
Cat. LA-5168 **Was $14.95**
Xmas $10

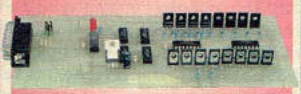
PREPROGRAMMED & PROGRAMMABLE REMOTE CONTROL

Controls up to 4 units.
Cat. AR-1705 **$79.95**

PRE- PROGRAMMED REMOTE CONTROL

Cat. AR-1700 **$34.95**

STEPPER MOTOR CONTROLLER KIT



See 98 cat P16. Cat. KC-5157
Was $45 Save $7.50
Now $37.50

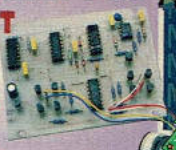
MULTI-SPARK CAPACITOR DISCHARGE IGNITION KIT

See cat P10.
Limited qty.
Cat. KC-5232

Was $99.50
Now $79.50 Save $20

MANUAL STEPPER MOTOR KIT

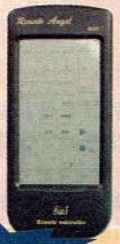
See 98 cat P16.
Cat. KC-5226



Was $19.95
Save $4
Now $15.95

LCD REMOTE WITH BACK LIGHT!!!

Operates up to 8 pieces of equipment
Cat. AR-1725
Only $169.50



KNOCK SENSOR KIT FOR CARS

See 98 cat P10.
KC-5203

Was $34.95
Save $8
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STEPPER MOTOR POWER SUPPLY KIT

See 98 cat P16.
Cat. KC-5237
Was $59.50
Now $49.50
Save $10

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SEE S.C. 6/98
Cat. KC-5248

Was $64.95
Save $13
Now $51.95

STEPPER MOTOR DRIVER KIT WITH BUFFER

See 98 cat page 16.
Cat. KC-5236

Was $55
Save $15
Now $40

IDEAL XMAS GIFTS

See our 98 Cat. page19 for full details.

30 IN ONE ELECTRONIC PROJECT LAB

Cat. KJ-7020

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60 IN ONE ELECTRONIC PROJECT LAB

Cat. KJ-7025

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NEW SPEAKER BOOKS

THE LOUDSPEAKER DESIGN COOKBOOK

The ultimate source for everything you need to know to build that dream loudspeaker for your home, your car, or your new home theatre. Softcover 28 x 22cm 165 pages. Cat. BA-1400 **$69.95**

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This book is a complete guide showing you how to build four, easy to construct, fully tested, two-way loudspeaker systems that perform brilliantly at a surprisingly modest cost. Softcover 28 x 22cm 112 pages. Cat. BA-1402 **$49.95**

ULTIMATE AUTO SOUND

A must for sound enthusiasts who are serious about the quality of sound in their car, van, or truck. Softcover 27 x 21cm 99 pages. Cat. BA-1412 **$19.95**

GEAR CHANGE INDICATOR KIT

BOX NOT INCLUDED

REF: Silicon Chip Sept '98
Improve your cars acceleration times with the small investment of this Gear Change Indicator Kit. A light will flash & buzzer will sound when the preset speed for each gear is reached thus improving your driving technique for optimum acceleration times. Supplied with PCB & all electronic components. Cat KC-5250

Was $37.95 Now $32.95 Save $5

SAVE ON STEPPER MOTORS ALSO!!!

All motors supplied with data and applications information.

SANKYO 7.5° Step Hi Torque
Was $28
Now $20
Save $8
Cat. YM-2750

MINEBEA 7.5° 6Ω Coils
Was $20 Save $10
Now $10
Cat. YM-2752

MINEBEA 7.5° 15Ω Coils
Was $16 Save $6
Now $10
Cat. YM-2754

BUY 10 LESS 10%

500W AMP MODULE KIT

See 98 cat page 5. Heatsinks not supplied.
Cat. KC-5231 **Was $199 Save $29.50 Now $169.50**

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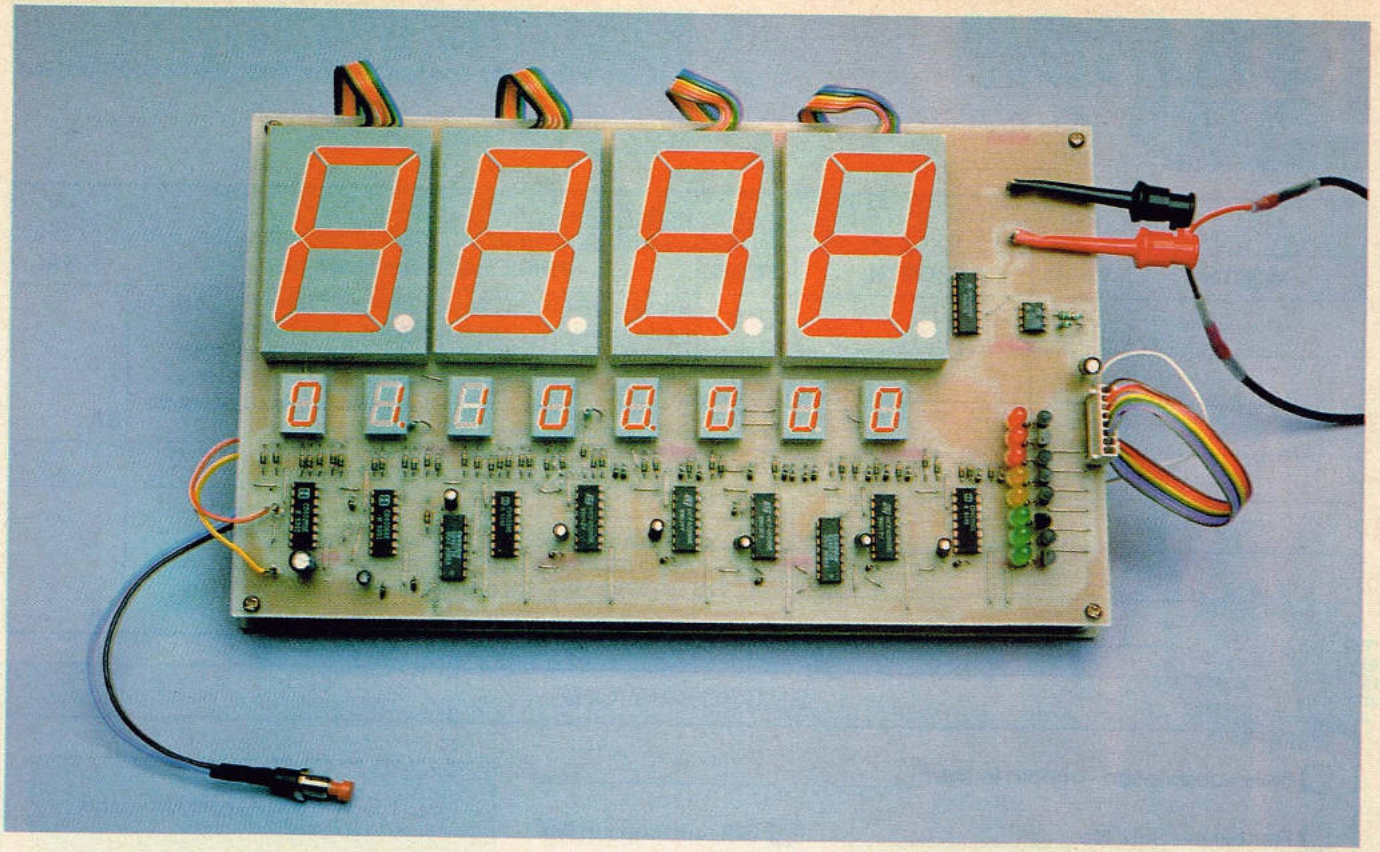


Build Your Own Poker Machine; Pt.2

Although it uses lots of parts, our new Poker Machine is very easy to build. Just follow the instructions below and you'll soon be losing your shirt – metaphorically speaking, that is!

By ANDERSSON NGUYEN

As noted last month, this project is built on two PC boards: a main board (code 08112981) and a display board (code 08112982). The display board is mounted on top of the main board using 20mm spacers and machine screws and nuts. You can even mount the completed assembly beneath a perspex sheet or in a wooden case, if you wish.

In all, there are 35 ICs on the two PC boards and 33 of these are CMOS types. This means that you should take care to prevent damage to the devices by static electricity. Always leave the devices in their antistatic packaging until you are ready to solder them into circuit and avoid touching any of the pins.

Provided you exercise reasonable care, you shouldn't have any problems but if you're really cautious, you can invest in an antistatic wrist strap.

Before installing any of the parts, go over the two etched PC boards carefully and compare them with the published patterns (Fig.5). It's much easier to locate and fix any defects at this stage than after all the parts have been installed.

You will need a soldering iron with a fine tip for this job, since many of the pads and tracks are in close proximity to each other. The use of IC sockets is optional. They make it easy to change a suspect IC but they also add to the cost. Usually, you can solder the ICs straight in without any problems.

Building the main board

The assembly can start with the main board – see Fig.3. Begin by in-

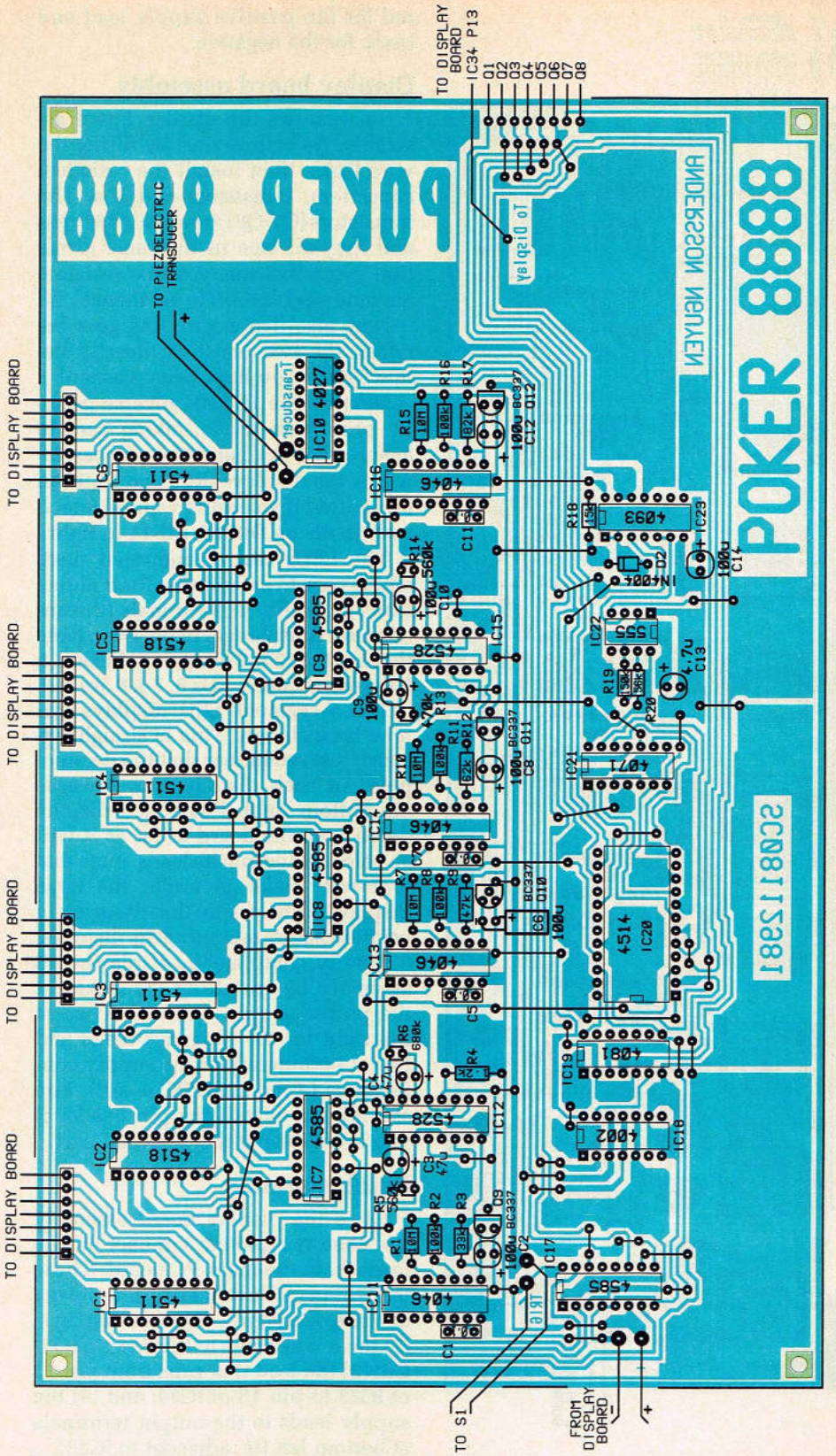


Fig.3: install the parts on the main board as shown in this wiring diagram. Note particularly that IC22 (555) faces in the opposite direction to the other ICs.

stalling the numerous wire links, then install the resistors and capacitors. The accompanying table shows the resistor colour codes but it's also a good idea to check the resistor values using a DMM, just to make sure. Make sure that the electrolytic capacitors are correctly oriented and note that several of the resistors (R5, R6, R13 & R14) are mounted end on.

The transistors and diode D2 (1N4004) can go in next. Again make sure that they are correctly oriented and make sure that transistors Q9-Q12 are BC337s.

Now for the ICs. These can all be installed in their correct locations, noting particularly that IC22 (555) faces in the opposite direction to the other ICs. Pin 1 of each IC is identified by a small notch or dot in the plastic body at one end.

Do not touch any of the IC pins. If you need to bend them so that they go in the holes, just push a row of pins along one side against the top of the bench (but do it gently).

The buzzer is attached to a vacant spot on the PC board (see photo) using double-sided adhesive tape. Alternatively, you can glue it in place using a small dab of epoxy adhesive. The leads of the buzzer are then soldered to the PC board, or you can terminate the leads on a couple of PC stakes if you wish.

External wiring

Once all the parts are in, you can add the external wiring leads. Begin by cutting four 8cm lengths of 7-way rainbow cable plus a 10cm length of 8-way cable. The four 7-way lengths are connected along the top of the board adjacent to the 4511 display drivers, while the 8-way cable is soldered to the righthand side of the board near the buzzer.

We terminated the 8-way cable in a ribbon cable header and this plugs into a matching pin header on the display board. However, these parts are optional and you may elect to save money by soldering the 8-way cable directly to the display board instead. The 8-way cable, by the way, connects to the bases of transistors Q1-Q8 on the display PC board.

Another lead is also run from pin 11 of IC23 to the display board, where it connects to pin 13 of IC34. The pad for this lead is immediately to the left of the pads for the 8-way cable. This lead can also be about 10cm long and can be run using light-duty hookup wire.

The assembly of the main board can now be completed by fitting the leads for the Play switch (S1) and for

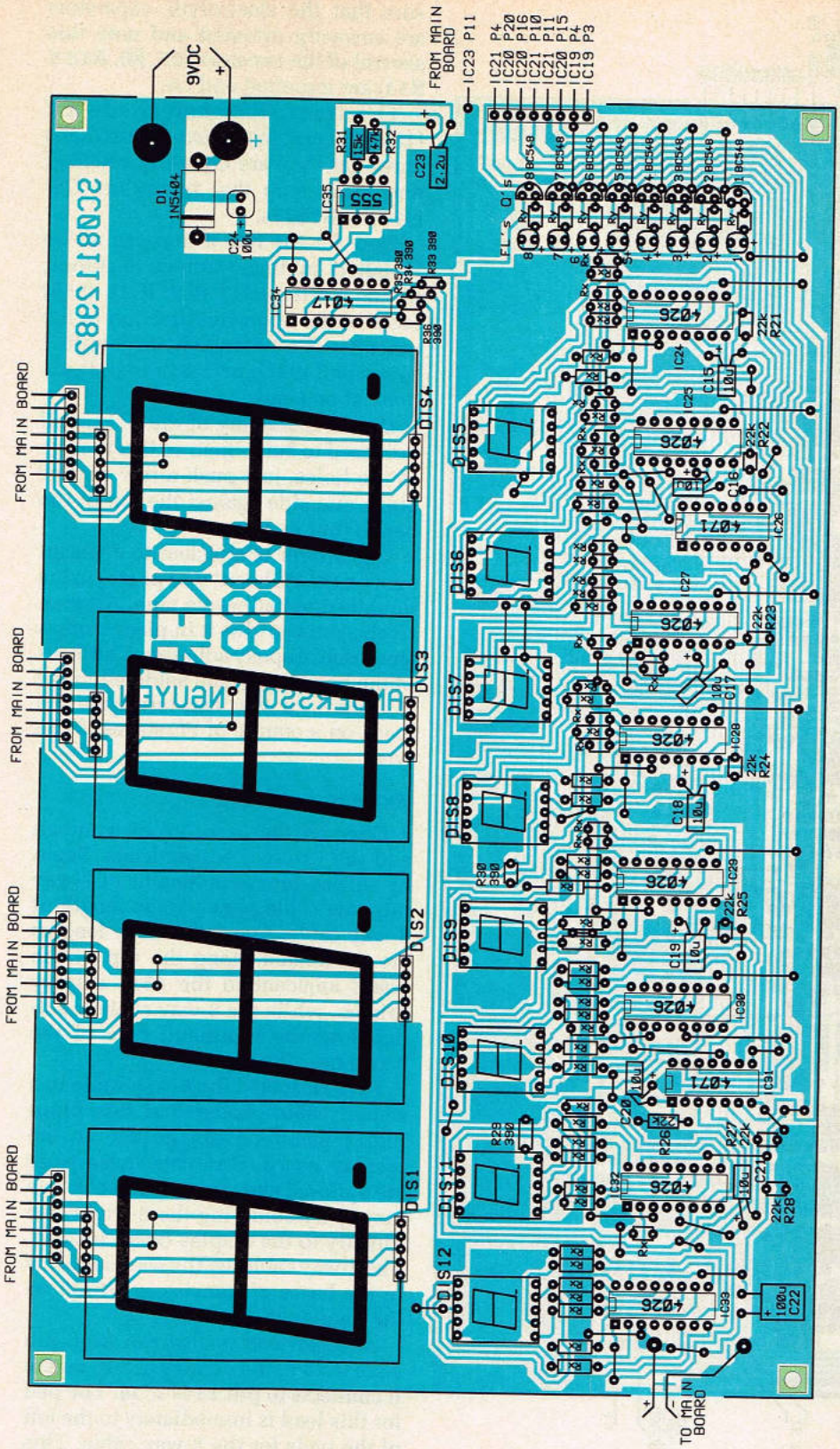


Fig.4: the parts layout for the display board. Make sure that all the displays are correctly oriented. The resistors marked Rx and Ry are all 330Ω.

the power supply. These leads are terminated on PC stakes and should be run using medium-duty hookup wire.

The leads for the Play switch can be about 160mm long, while the supply leads can be about 80mm long. Use red for the positive supply lead and black for the negative.

Display board assembly

Fig.4 shows the display board assembly. As before, start by fitting the wire links, then install the resistors, capacitors, transistors and ICs. The transistors (Q1-Q8) are all BC548 types and they all face in the same direction. Note that many of the resistors are mounted end-on to get them to fit.

Note also that a wire link goes between the two resistors directly below DIS9 – you have been warned!

Next, fit the 1N5404 reverse polarity protection diode, taking care to ensure that the banded end goes towards the displays. R29 and R30 can be omitted if you don't want the decimal points on DIS8 & DIS11 to light.

The LEDs can be mounted next, taking care to ensure that their anode leads go to the "+" terminals (the anode lead is the longer of the two). Note that LEDs 1, 2 & 3 are green, LEDs 4 & 5 are orange and LEDs 6, 7 & 8 are red.

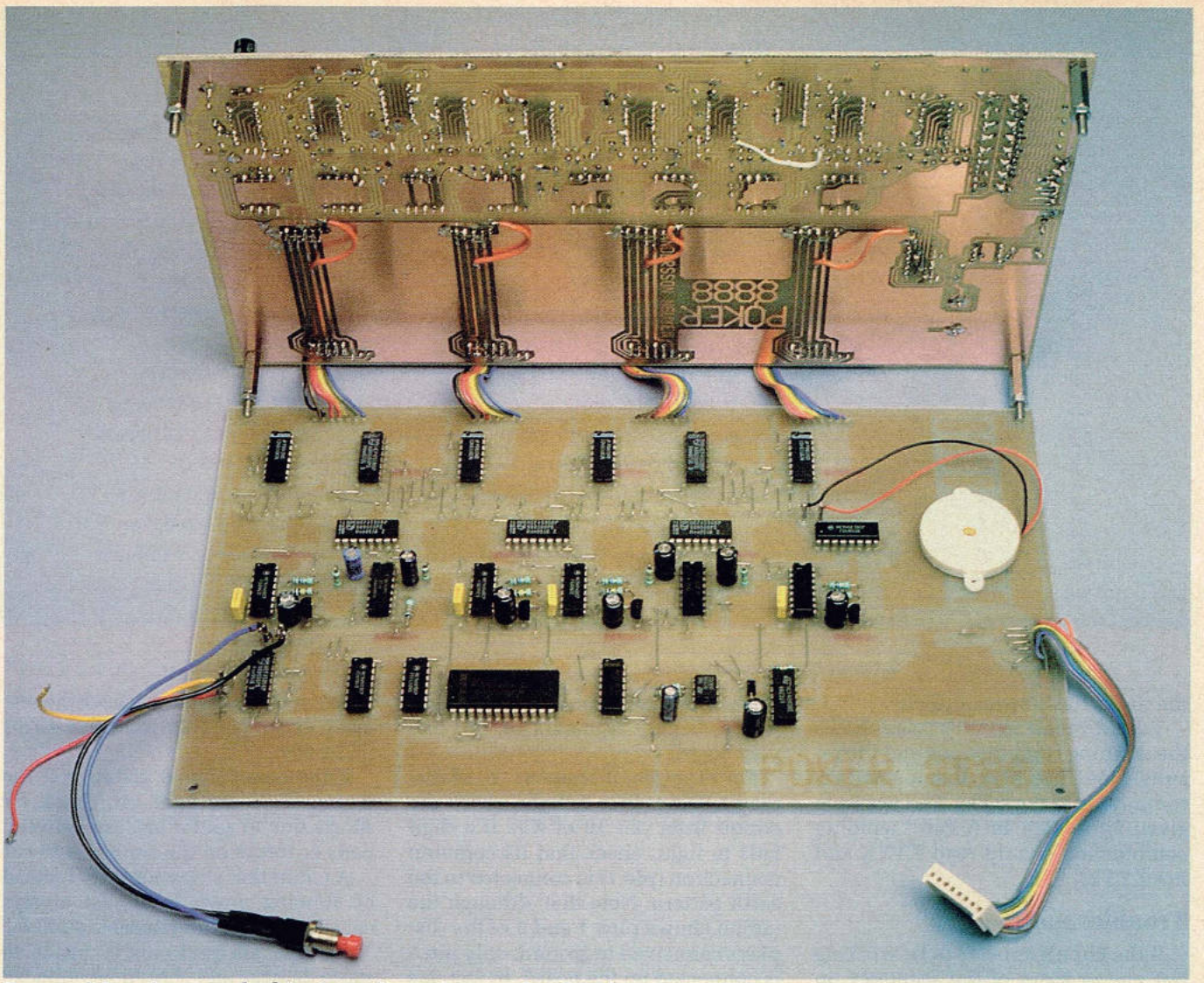
The 7-segment LED displays can now be installed. This is straightforward; just remember that the decimal point of each display goes towards the bottom right. Push each display down onto the board as far as it will go before soldering its leads. Note that four wire links go under the large displays so make sure that these are in position before mounting the displays.

Finally, complete the display board assembly by installing PC stakes at the power supply terminals (two at top right for the plugpack leads and two at bottom left for the supply connections to the main PC board). You should also install the pin header if you intend using this optional part.

Final assembly

Once the display board assembly has been completed, connect all the leads from the main PC board. These leads are as follows: (1) the four 7-way cables to the large 7-segment displays; (2) the 8-way cable to the bases of Q1-Q8; (3) the lead that runs from pin 11 of IC23 to pin 13 of IC34; and (4) the supply leads to the output terminals at bottom left (ie, adjacent to IC33).

Take extra care when connecting the supply leads between the two boards. The positive terminal on the display board (near IC33) is the topmost terminal. Conversely, the positive terminal is the bottom-most of



Repeated from last month, this photo shows the completed PC boards just before they are stacked together. Ignore the wire links shown on the back of the display board – we changed the PC pattern to eliminate these for the final version.

the supply terminals on the main board. Do not get them mixed up, otherwise you could damage some of the semiconductors.

With the wiring completed, the two boards can be stacked together and secured using 20mm spacers and machine screws and nuts. It would be a good idea to fit small rubber feet to the bottom of the display board, so that it doesn't scratch the desktop.

Alternatively, you might like to build the assembly into a wooden case, with a clear Perspex window for the LED displays. The Play switch can be suitably mounted on the front panel.

Testing & operation

Power for the circuit comes from a 9V 1A plugpack supply (do not use a 12V supply, as this could damage the displays). Connect the supply leads to the terminals on the display board (at top right), apply power and check that the LED displays come on.

Initially, the large 7-segment displays will display a random result. The digits may all be off, cycling or stationary; or you may have a mixture of these conditions. The smaller 7-segment LED displays (ie, the scoreboard arrays) should all initially display "0", while the LED score indicators at bottom right should all be off.

Now press the Play switch. The large displays should immediately begin cycling and the transducer should produce a rapid clicking sound to simulate the sound of the "rolling barrels". After a short period, the displays should slow down and eventually stop, starting with the most significant digit and finishing with the least significant.

Note that the first "play" will take some time to come to a stop, due to the way the circuit works. Subsequent plays will finish much faster, so be patient the first time around.

If it all works so far, press the Play button a few more times until you get a winning combination. When this happens, check that the corresponding indicator LED flashes and that the credits are incremented on the scoreboard displays.

For example, if you get a pair, LED 1 should flash and the scoreboard should increment by 1. Similarly, if you get two pair (eg, 6633), LED 3 should flash and your score should increment by 100. If you get four of a kind, the decimal points should chase, while 0000 or 8888 will result in all

Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
4	10MΩ	brown black blue brown	brown black black green brown
1	680kΩ	blue grey yellow brown	blue grey black orange brown
2	560kΩ	green blue yellow brown	green blue black orange brown
1	470kΩ	yellow violet yellow brown	yellow violet black orange brown
1	150kΩ	brown green yellow brown	brown green black orange brown
4	100kΩ	brown black yellow brown	brown black black orange brown
1	82kΩ	grey red orange brown	grey red black red brown
1	62kΩ	blue red orange brown	blue red black red brown
1	56kΩ	green blue orange brown	green blue black red brown
1	47kΩ	yellow violet orange brown	yellow violet black red brown
1	33kΩ	orange orange orange brown	orange orange black red brown
8	22kΩ	red red orange brown	red red black red brown
2	15kΩ	brown green orange brown	brown green black red brown
1	1.2kΩ	brown red red brown	brown red black brown brown
6	390Ω	orange white brown brown	orange white black black brown
64	330Ω	orange orange brown brown	orange orange black black brown

the digits flashing on and off.

Table 1 in last month's issue shows the winning combinations and the results. Note, however, that a small error crept into the table. The example given for a "Pair In A Pair" winning combination should read XYYX and not XYYZ).

Troubleshooting

If the circuit appears to be working but one or more of the segments on the large displays is missing, check the wiring to the displays between the two boards. It's possible that one of the leads may have broken.

If the wiring is OK, check for breaks in the copper tracks at the display driver outputs (pins 9-15 of IC1, IC3, IC4 and IC6 on the main board). In addition, check for breaks in the tracks to the display segments on the display board.

For example, if segment "f" of display 4 (DIS4) fails to light, check the circuit from pin 16 of IC6. If a digit fails to light, check that its common connection (pin 1) is connected to the earth pattern. Note that although the circuit shows pins 1 and 5 of the displays connected to ground, only pin 5 is connected on the board. In fact, it's a good idea to run an insulated link between pin 1 and the nearby earth pattern on the PC board, to make the earthing more secure.

If the connections are OK, check the supply voltages on the relevant display driver and check its outputs.

Similarly, if you have trouble with the scoreboard displays, check the segment driver outputs from the 4026s (IC24-33).

If the count jumps about or if the wrong segments light up, check for shorts due to solder bridges between pads or tracks on the copper pattern.

A count that stops abruptly instead of slowing down is almost always caused by a static-damaged 4046 IC. These ICs are particularly prone to static damage and should be replaced if you have any doubts.

If there are other problems, check the two boards carefully for missed solder joints and other soldering errors. You should also check that all the parts are in their correct locations and that you haven't left out any wire links. It's also a good idea to check the supply voltages to all the ICs. If any of the supply voltages is missing, then you're halfway to tracking down the problem – just backtrack along the supply rail to find out where the problem occurs.

Laws of probability

Once complete, the circuit will provide you with hours of fun without costing a cent more. Obtaining a pair or even two pair is relatively easy but three of a kind is much more difficult. You'll also quickly realise just how difficult it is to get four of a kind, let along four eights or four zeros.

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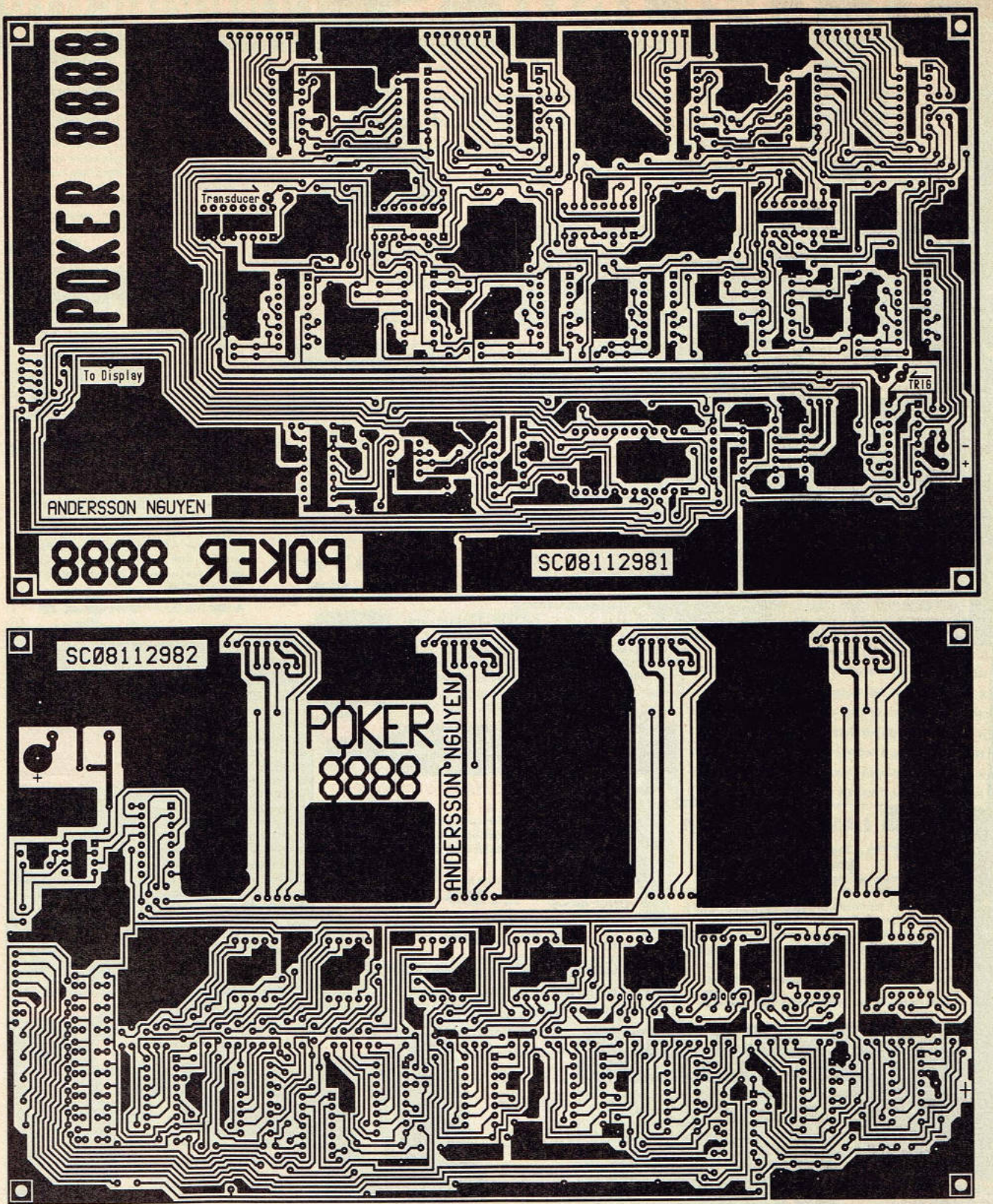

Fig.5: the PC etching patterns have been reproduced here 71% of actual size. You can get full-size patterns by copying them on a photocopier set to a standard 1.41 enlargement factor.

Probability is indeed against you and you'll soon realise that with a real poker machine, which generally has five digits and more than 10 possibilities for each, the chance of a favourable combination is highly unlikely. Hopefully, this will discourage you from throwing your money away on them. **SC**

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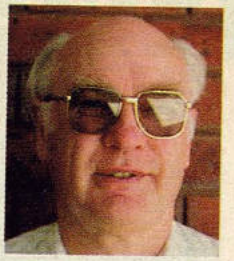
VINTAGE RADIO

By RODNEY CHAMPNESS, VK3UG



Improvements to AM broadcast band reception; Pt.2

This month, we look at some practical antennas that you can make to dramatically improve AM broadcast reception. Both long wire and loop antennas are described.

In the first article, the theory behind improving AM radio reception was discussed. In particular, it is important to have a good antenna and earth system, located in an area where signals are good and interference minimal. The location is particularly important, to minimise interference from man-made sources.

In this article, some practical methods of improving AM radio reception will be described. In some cases, a relatively simple method will suffice. However, more elaborate systems are required in very noisy locations or where long distance reception is required. Often, it will be necessary to experiment to find which method or methods give the best results.

"Long" wire antennas

The "long" wire antenna is easy to erect and can give quite good results. "Long" wire is a relative term and is generally used to mean long in relationship to the wavelength of the radio wave received. However, it is obviously a short wire antenna in relation to AM broadcast band wavelengths but the term has stuck.

Older receivers of the pre-transistor era almost universally have aerial/antenna and earth terminals. Most of the later valve receivers have a loopstick aerial as well and in most suburban areas perform quite well, as the signals are strong. However, as time has progressed, houses have been built with metallised insulation paper in the walls and sometimes in the ceiling and under the floor, or have other metal structures that act as radio signal shields. Additionally, many new domestic devices, including personal computers, often create interference.

An outside antenna consisting of 5-15 metres of insulated wire taken out through the wall of the home and run along the eaves is usually sufficient to give quite a reasonable improvement to the reception. The antenna is away from the interference producing sources and the wanted radio signal outside is stronger. There is nothing magical about insulated wire except that it is easier to handle and prevents shorts.

If reception is still not good enough, a longer and higher outside antenna is needed. In the early days of radio, outside antennas were commonly 30 metres long and around 13 metres high. However, antennas of such dimensions are clearly not practical in the average domestic environment. For best performance, the antenna should be high and long but anything higher than 5 metres and longer than 15 metres will be reasonably effective.

The antenna can be installed as shown in Fig.1. Note that the extra wire which goes up to the antenna proper (the wire that goes from the earth but does not connect to the antenna) can be omitted in this instance. It is used in another antenna system to be described shortly.

The antenna lead to the outside of

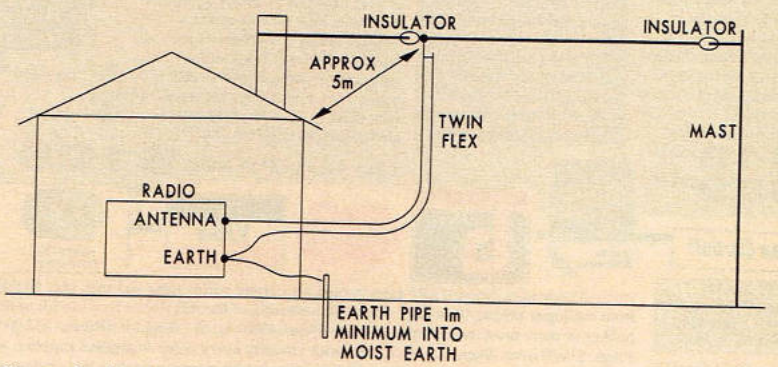


Fig.1: the basic scheme for a "long" wire antenna. Note that the extra wire which goes up to the antenna proper (the wire that goes from the earth but does not connect to the antenna) can be omitted if noise isn't a problem – see text.

the home should be as short as reasonably practical and should be kept well away from any electrical appliances and wiring to reduce the likelihood of interference pickup. The mast that the television antenna is attached to, or a chimney, are convenient spots to attach one end of the antenna support cable.

As shown in Fig.1, the end of the antenna is kept well away from the house to reduce interference. It is suggested that the wire between the set and the horizontal section of the antenna be insulated. It should also be resistant to the Sun's ultraviolet rays.

By using ordinary domestic electrical twin flex, it is possible to modify the antenna from an ordinary outside antenna to a noise reducing type. This is done by connecting or disconnecting the "unused" lead from the set's earth terminal.

The horizontal section of the antenna can be insulated or bare wire. A cheap wire is tie wire which is used in the garden. At around 18 gauge, it is quite adequate for the job, being strong, light and inexpensive. Copper wire is not needed.

The "egg" insulators at the ends of the antenna can be obtained from some of the retailers who advertise in this magazine or from suppliers who sell electric fence components. All wire joins in the various parts of the antenna must be soldered if they are out in the weather, otherwise the reception will be spoilt by crackling when wind moves the antenna (particularly if corrosion sets in).

Fig.2 shows the wiring to the egg insulators. It is important to ensure that minimal stress is placed on the wire where it joins the antenna proper.

An external earth may not be needed to give the improvement in reception that is desired. However, if you are going to all this trouble, it is desirable to install a radio earth as well, even though the radio may already be earthed via the mains. The radio earth can be a 1.5 to 2-metre length of 19mm galvanised water pipe driven into moist soil near the side of the home. The earth wire is clamped to the pipe with an electrician's earthing clamp or a screw-type hose clamp. The joint needs to be cleaned and, when everything is tightened up, painted to retard any corrosion (see Fig.1 in last month's column).

Note that the earth wire should be reasonably heavy gauge insulated wire. If the set chassis is earthed, it is desirable to place a .001µF to .01µF mica or polyester capacitor in the newly installed radio earth lead before it attaches to the set. This is to prevent this earth from taking the place of the mains earth.

The next improvement is to make the long-wire antenna a "noise reducing" type. This is achieved as shown in Fig.1, by running a twin wire lead up to the antenna proper. This lead can be domestic electrical twin flex or 300-ohm twin black ribbon television cable. The latter will last much longer as it is treated to resist ultraviolet radiation.

Don't use the clear cable; it has no UV protection and will deteriorate within about 12 months if it is out in the weather.

Which ever cable is used, it should be supported using both leads. Note that the second unterminated wire is left with its insulation intact so that the wire touches nothing and so that it can be tied to the antenna. It must be attached so that it doesn't chafe.

The advantage of this scheme is

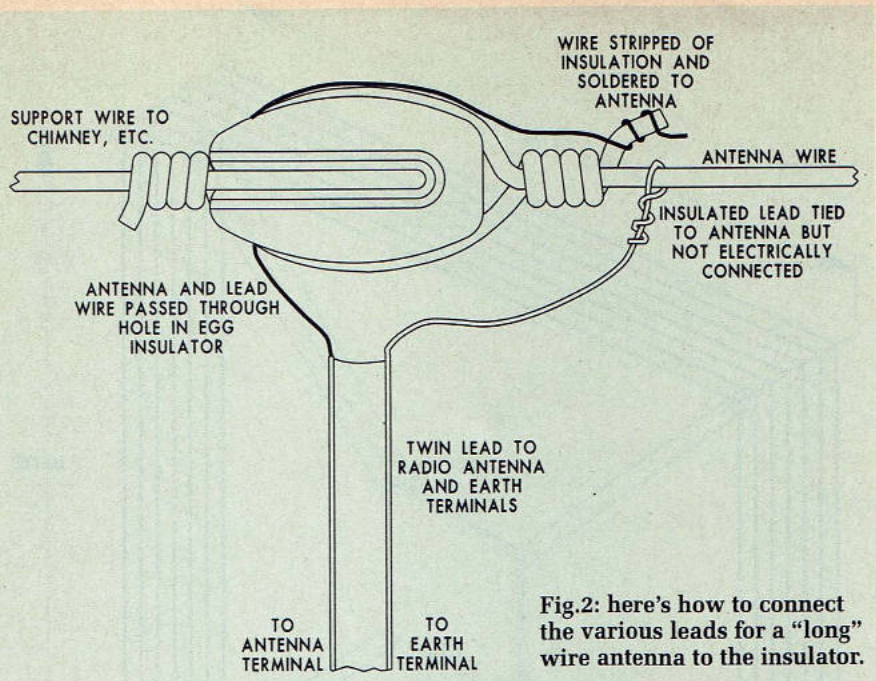

WIRE STRIPPED OF INSULATION AND SOLDERED TO ANTENNA
SUPPORT WIRE TO CHIMNEY, ETC.
ANTENNA WIRE
INSULATED LEAD TIED TO ANTENNA BUT NOT ELECTRICALLY CONNECTED
ANTENNA AND LEAD WIRE PASSED THROUGH HOLE IN EGG INSULATOR
TWIN LEAD TO RADIO ANTENNA AND EARTH TERMINALS
TO ANTENNA TERMINAL
TO EARTH TERMINAL

Fig.2: here's how to connect the various leads for a "long" wire antenna to the insulator.

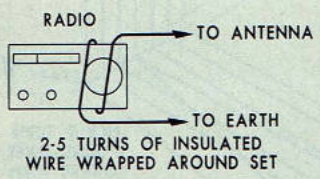


Fig.3: a "long" wire antenna can be inductively coupled to a portable radio by winding a few turns around the set, as shown here.

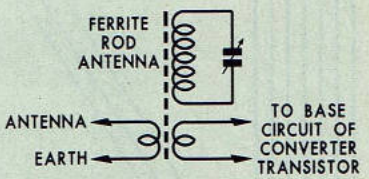


Fig.4: another way of coupling a "long" wire antenna to a portable set is to wind a few turns of insulated wire around the loopstick antenna.

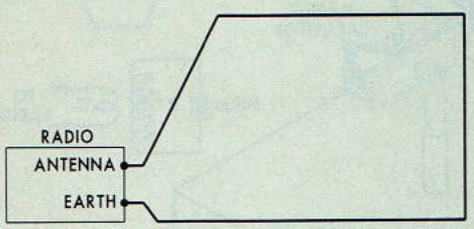


Fig.5: (left): an untuned loop antenna gives less signal strength but is quite effective at reducing interference.

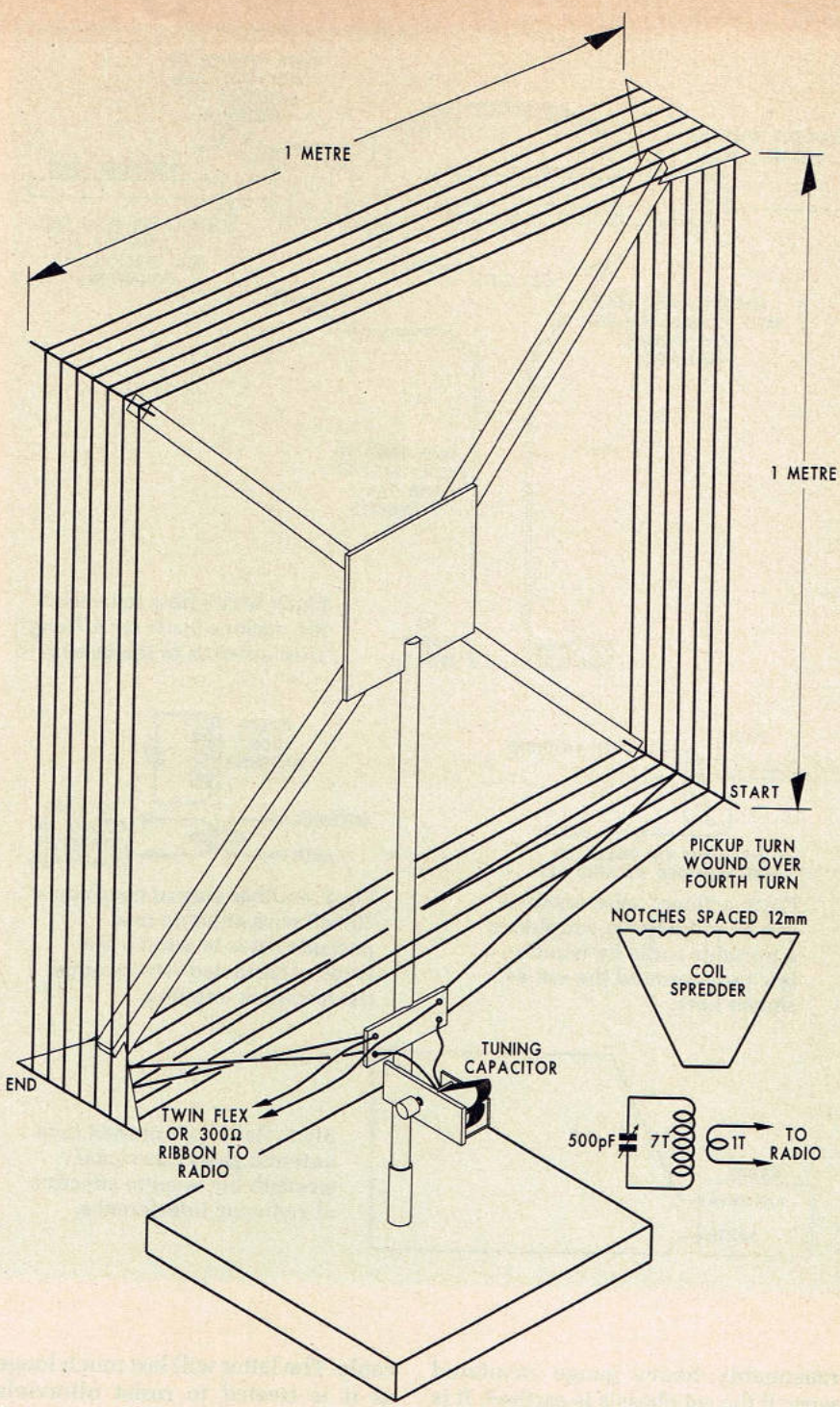


Fig.6: a tuned loop antenna can dramatically improve AM broadcast reception. It is less responsive to interference sources than a "long" wire antenna and it is directional. This means that unwanted interfering stations can often be nulled out by rotating the loop.

that the twin wire from the antenna proper to the set picks up very little signal, as one wire is earthed and acts as a shield for the other. This means that, if it goes through a noisy area on it way to the set, no extra signals are picked up and so the radio receives a signal that is largely noise-free.

There are a couple of disadvantages, however. Because the "shielded" section of cable doesn't pick up any signal, the effective length of the antenna is reduced compared to using an unshielded down lead. In addition, some signal is lost due to the proximity of the earthed wire to the signal-carrying wire. This means that a slightly larger long-wire antenna may be needed to overcome these losses.

Note that 300Ω TV cable has less capacitance between its wires than electrical twin flex and will have less loss of signal. However, it may pick up a small amount of interference.

Long-wire antennas & transistor sets

How can the long wire antenna be used with a transistor set that needs a boost in performance? This is quite a problem as most transistor sets have no external antenna and earth terminals. One solution is to remove the back from the set and wind a few turns of insulated wire around the loopstick antenna. This is then connected to the antenna and earth wires coming into the house.

However, before doing this I would suggest a different approach. This involves winding 2-5 turns of insulated wire around the set as shown in Fig.3. You then connect one end of the winding to the antenna and the other to the earth.

Now turn the set on and tune across the broadcast band. If the set is a good one, it will be found that previously noisy stations are much clearer and additional stations will become quite audible. However, if the set is the typical mass-produced suburban "cheapie", the results may be disappointing. In addition to the wanted stations, many stations may appear in odd spots on the dial, along with shortwave and Morse code stations.

To add insult to injury, the stations that were originally heard well may now have other stations interfering with them. So putting up this lovely new antenna/earth system has, in this instance, been a complete disaster.

What has caused this, and how can good clean signals be obtained for transistor sets, so that the expected improved reception can be obtained?

The cause of the problem was mentioned in the first article: poor selectivity in the receiver's antenna circuit. In addition, the "link" winding to the base of the autodyne converter transistor couples nicely with the link winding that has just be placed around the receiver (see Fig.4). This means that shortwave signals will easily be transferred from the antenna link winding to the transistor base winding.

This base winding will have a tendency to be broadly resonant in the shortwave bands. This would not be a problem in itself were in not for the fact that the local oscillator generates many harmonics in addition to the wanted oscillator frequency. As a result, the shortwave stations beat with the oscillator harmonics and produce the multitudinous unwanted signals.

Some of the better sets don't suffer from this problem but most do. The way around the problem is to increase the selectivity of the receiver and the procedure will be described later.

Loop antennas

In the past, many people simply connected 5-10 metres of insulated wire to the antenna terminal of a valve radio. This was often laid around the skirting boards and reception in most cases was satisfactory. However, it was soon shown that if the wire was run along the picture rail and then doubled back along the skirting board, the reception was just the same.

The next step was to connect the end that had been doubled back to the set earth. "The set earth!", you might say. "That will short the signal out!" Not so – the antenna wire in fact becomes a large untuned loop antenna and its effectiveness in picking up signals is governed by the area within the loop. What will be noticed is that while the signals are a little weaker, the interference completely disappears in many cases.

In this case, the antenna system has been changed from a "long" wire (electric field pick-up) antenna to a loop (magnetic field pick-up) antenna, just by earthing the end of the antenna. This is a simple way of assessing the effectiveness of the two types of antennas. So let's now take a look at the loop antenna types that can be used.

Loop antennas have been used since the very early days of wireless (radio) in a variety of forms. Some of the early sets had a loop antenna sitting on top of them. They were rather bulky and so were the sets. Gradually, the loop gave way to the "long" wire antenna, which meant less bulk in the lounge room.

As radio progressed, the valves and components became smaller and portable battery radios were developed. The early sets used a spider web weave loop antenna (coil) in their back which nominally measured around 25 x 18cm. These were reasonably efficient although not as good as the ones used in the sets of the 1920s which measured up to 60cm square.

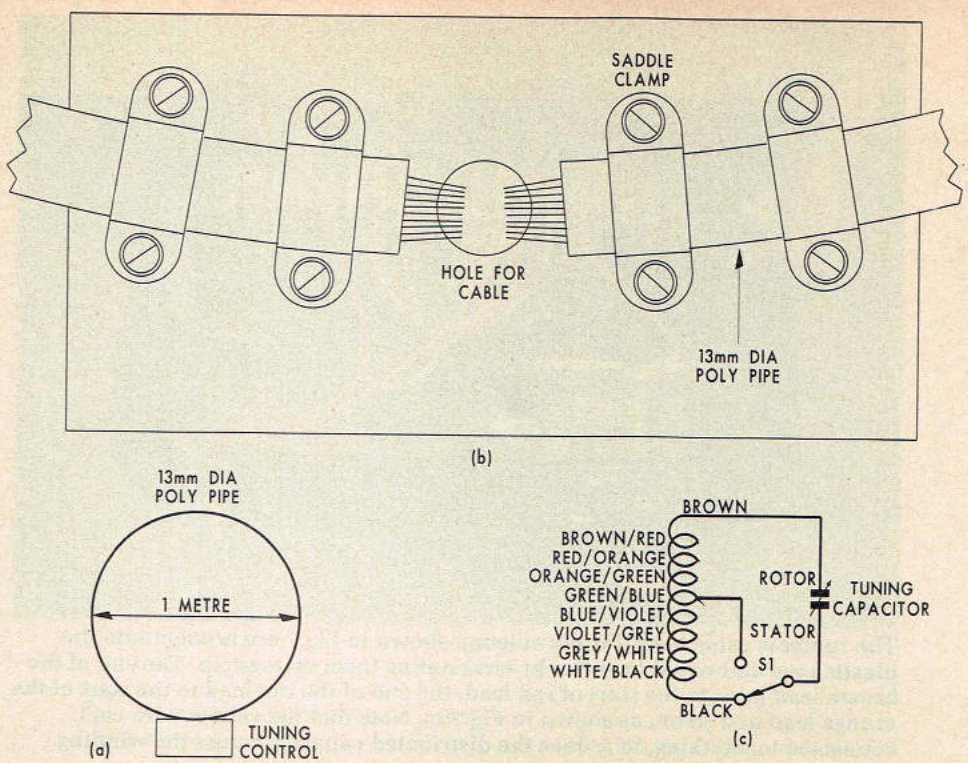


Fig.7: an alternative scheme for a practical loop antenna. It uses a loop made from 13mm polythene pipe and 10-conductor rainbow cable. The bottom ends of the loop are secured to a standard plastic case using saddle clamps – see text.

In the early 1950s, the flat wire loop was gradually replaced with the new ferrite loopstick antenna. These units were more compact than the large loops in the back of portables.

However, they weren't particularly small in Australian-made high-performance sets (transistor sets in particular), commonly measuring 200mm long x 13mm in diameter (and a few were even larger than that). Cost considerations meant that the size was reduced in later years and some ferrite rods are now just 40 x 8 x 4mm. These are found in sets intended for use with signals from strong local stations.

Practical loop antennas

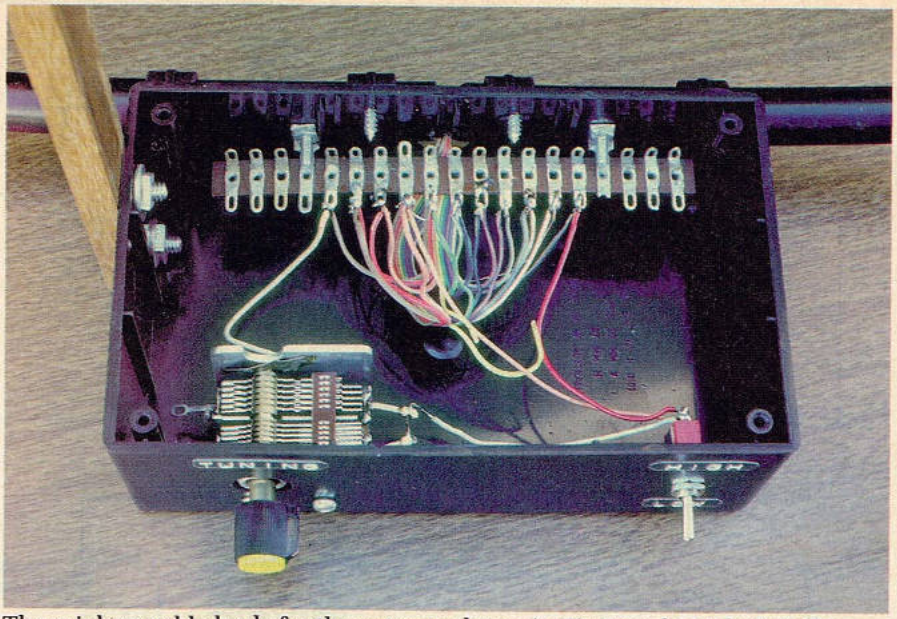
Let's now take a look at two loop antennas that you can build to dramatically improve reception and reduce the deleterious effects of interference.

The first antenna has a loop diameter of nominally 1 metre. It consists of a frame made of wood or plastic, as shown in Fig.6. The tuned winding consists of 7 turns of wire spaced around the extremities of the loop frame. The beginning and end of this winding terminate to the stator and rotor terminals respectively of a single-gang variable capacitor (or you can use one gang of a dual-gang variable capacitor).

The seven turns will tune across the broadcast band with a tuning capacitor of around 400pF. If the gang has only about 300pF maximum capacity (eg, if two sections of a miniature tuning gang for a transistor radio are paralleled), an additional turn or two may be required to cover the broadcast band completely (you may have to experiment to get the best results).

An additional (separate) pickup turn is also wound around the frame and this is terminated on the insulating plate and then connected to the antenna and earth terminals of the set via a 300Ω ribbon cable (TV twin lead).

Provided it is suitably weatherproofed, this antenna can be located outside, away from noise sources. The disadvantage is that it can only be tuned to nominally one station, which means that you have to go outside to



The rainbow cable leads for the antenna shown in Fig.7 are brought into the plastic case and wired in series by terminating them on tagstrip. The end of the brown lead joins to the start of red lead, the end of the red lead to the start of the orange lead and so on, as shown in Fig.7(c). Note that the yellow wire isn't connected to anything, to reduce the distributed capacity across the winding.

retune the loop. However, if you only wish to listen to one station, that is no problem.

Another approach is to use varicap diodes instead of a mechanical tuning capacitor. This will enable the antenna to be remotely tuned via a variable DC voltage which can be fed down the antenna twin lead or coaxial cable from the receiving location.

This loop antenna has two advantages over a long-wire antenna: (1) it is less responsive to interference sources; and (2) it is directional, so that (in some situations), unwanted stations can be nulled out by rotating the loop.

The second loop antenna

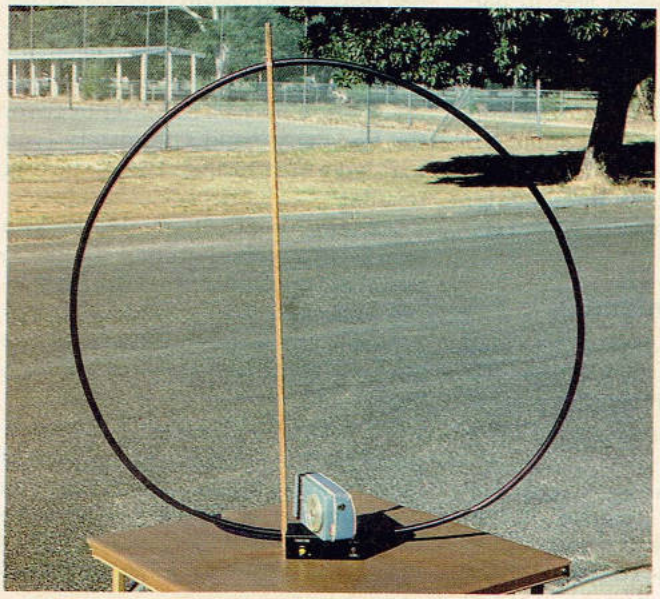
Another variant of this loop antenna – which in some ways is easier to construct – uses 13mm-diameter polythene pipe as the former for the wires. The wires are slid inside the pipe but you don't have to slide them in one-by-one. Instead, the trick is to use 10-strand rainbow cable.

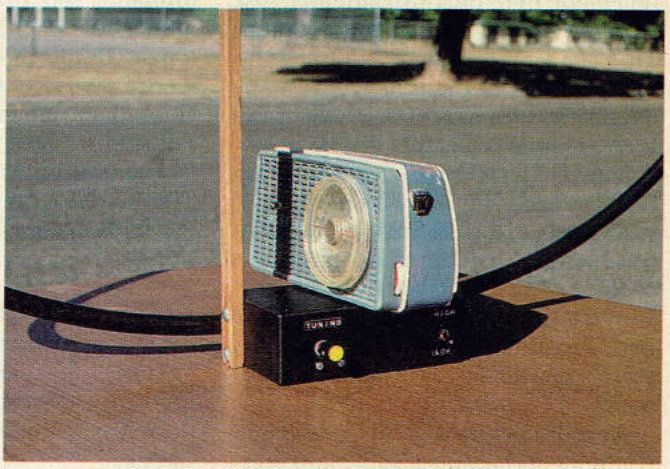
You will need 3.15 metres of 13mm polythene pipe plus four saddle clamps. In addition, you need a plastic case measuring at least 130 x 68 x 41mm, 3.25 metres of 10-conductor rainbow cable, an 11-lug terminal strip, a tuning capacitor, a knob, a SPDT toggle switch, a 1.2-metre length of timber or plastic conduit to support the top of the loop and some screws to mount the pieces of hardware.

The first step is to thread the wire through the pipe. To do this, attach a small nut to some cotton and feed this through first. This done, attach some string to the cotton and pull this through, then use the string to pull through the rainbow cable. Trim the rainbow cable to length, leaving about 80mm exposed at either end.

The assembly of the loop antenna can now commence – see Fig.7. Drill holes for the cable to go into the side of the box plus holes to accommodate the screws that go through the saddle clamps. The tuning capacitor is mounted inside the box. Very small variable plastic capacitors are easier to mount – if you can get suitable screws. In some cases, epoxy adhesive can be used instead but be careful how you apply it. The 11-lug terminal strip is also mounted in the box to terminate the leads of the rainbow cable.

The loop is now fastened to the back of the box using the four saddle clamps. The 1.2-metre length of timber is attached to the side of the case using two screws and is used to support the loop at the top. This ensures that the loop remains vertical and





A 1.2-metre length of timber is attached to the side of the case and supports the top of the antenna loop, so that it remains vertical. In operation, the radio is placed inside the loop (on top of the plastic case) and the loop tuned and rotated for best reception.

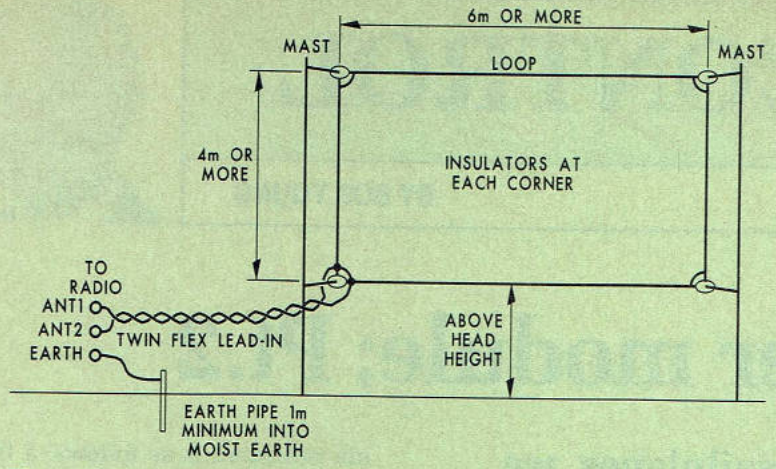


Fig.8: a large untuned loop antenna. It is more elaborate than the one shown in Fig.5 and is also a better performer. This type of antenna is more suited for use with a radio that is equipped with both antenna and earth terminals.

stops it from flexing – see photo.

The ends of the rainbow cable are brought in through the hole in the back of the box and connected to the terminal strip. Note that each wire is wired in series with the last one – see Fig.7(c). Begin by soldering the brown wire at the "start" end of the cable to the end terminal lug. Its "end" is then connected to the second lug, along with the red wire of the "start" end. The "end" of the red wire then goes to lug three, along with the "start" of the orange wire, and so on.

Note that the "end" of the orange wire attaches to the "start" of the green wire. The yellow wire (which comes after the orange wire) is not connected to anything. This is done to reduce the distributed capacity across the whole winding so that the loop will tune properly.

The sequence of the wiring then continues with the normal colour code progression, finishing with the "end" of the black wire going to the 10th lug.

Unfortunately, the distributed capacity is still too great for the loop to tune the whole of the broadcast band in one sweep. To overcome this problem, the brown wire from the loop connects to the rotor of the tuning capacitor. The SPDT switch is then used to connect the tuning gang stator (s) to either the junction of the green and blue wires or to the single black wire. The circuit diagram shows the connections. Remember to make sure any trimmers mounted on the tuning gang are adjusted for minimum capacity.

The loop is now ready to test. Tune a transistor set to a weak station, then place it in the loop and rotate the loop's tuning capacitor for best reception. All being well, a very noticeable improvement in reception will be observed.

Now tune the transistor radio to both ends of the dial to determine whether or not the loop covers the whole band. It may be necessary to vary the number of turns in use to cover the whole band, depending on the tuning capacitor used.

Rainbow cable has high distributed capacitance between turns, making it necessary to tune the broadcast band in two stages. If the turns are spaced away from each other, the distributed capacitance would be low and the whole band could be covered in one sweep. This type of loop is more difficult to make though.

Nulling unwanted stations

One very convenient feature of these two loop antennas is that by rotating them horizontally, it is possible to null out unwanted stations. This can make a big difference where a wanted station is being interfered with by an unwanted station. As long as the apparent directions of the wanted and unwanted stations are greater than 45 degrees apart, the results can be very satisfying.

Untuned loop antennas

Because of their size, tuned loops are usually not well accepted in a domestic environment. However, untuned loops can do all that the tuned loops can do and more, with the exception that they cannot be rotated to null an unwanted station out. They are also rather large but because they are mounted outside, they don't cause any inconvenience inside the home.

Fig.8 shows the large untuned loop antenna. It is more elaborate than the one shown in Fig.5 and is also considerably better. It is installed away from interference sources, usually in the back yard. It must be orientated so that the horizontal sections nominally point towards or away from the stations of interest. As with the tuned loop antennas, there will be a signal null at right angles to loop.

This type of antenna is more suited for use with a radio that is equipped with both antenna and earth terminals.

That's all we have space for this month. Next month, we'll describe how to make an antenna booster. **SC**

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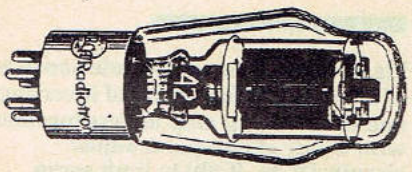

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RADIO CONTROL

BY BOB YOUNG

An F3b mixer module; Pt.2

In this final article on F3B sailplanes, we describe the circuit and construction of a mixer module to suit the encoder in the Silvertone Mk.22 transmitter. It provides a wide range of programmed functions using simple op amp stages.

Last month, we covered the operation of the basic building blocks to be used in this F3B module. These comprised inverting and non-inverting mixers and end-point clamps to limit servo travel in certain configurations.

If you are to fully understand how this module works, you will need to refer back to the circuit of the Mk.22 transmitter encoder which was presented in the March 1996 issue of SILICON CHIP. An 8-channel encoder, it has a column of 3-pin sockets of connections for the control sticks, auxiliary pots and toggle switches. Then there is a column of trimpots which are the ATV/dual rate set pots and another column of 3-pin sockets for the dual rate/normal/ATV programming pins.

These functions can be added onto via the TB10 mix/expand socket on the encoder board and this mates with the TB18 mix/expand plug on the F3B mixer module.

All control voltages from the transmitter front panel controls are available at TB10/TB18.

Fig.1 shows the complete circuit diagram of the module. Note that there are four pairs of mixers: IC1a & IC1b (Aileron slave), IC1c & IC1d (Droop/Crow), IC2a & IC2b (Flap/Elevator compensation) and finally IC2c & IC2d ("V" tail). IC3a & IC3b are the two end point clamps.

Included on the circuit is a panel giving the recommended channel allocation for this module. TB11 is the patch cord plug for each channel and is numbered 1-8 from top to bottom. The pre-programming assumes this channel allocation is adhered to.

As stated last month, the module essentially consists of matched pairs of mixers, one inverting and one non-inverting. Each mixer pair is fitted with 3-pin input and output plugs arranged in such a way that the pre-programmed functions can be activated by fitting micro-shunts. These input/output plugs may also be remotely switched or hard wired as the application demands.

Alternatively, each op amp mixer may be used as a free mixer (non-programmed) by using a patch cord which is rotated 180 degrees to pick up the input and output pins, as illustrated last month.

The pre-programmed lines have been drawn with heavy lines and they all begin and end at TB18 because we are drawing on a portion of the control voltages applied to the multiplexer inputs (4051) located on the main encoder PC board. We then modify them and reapply this modified control voltage back to the appropriate multiplexer inputs. All of this takes place via TB18.

The pre-programming on the module presented is as follows: a three-servo wing for flaps, slaved aileron servo, flap/elevator compensation, Droop/Crow and "V" tail. The four-servo wing setup (two flap servos) uses one of the free mixers, either on the module or the encoder via a patch cord.

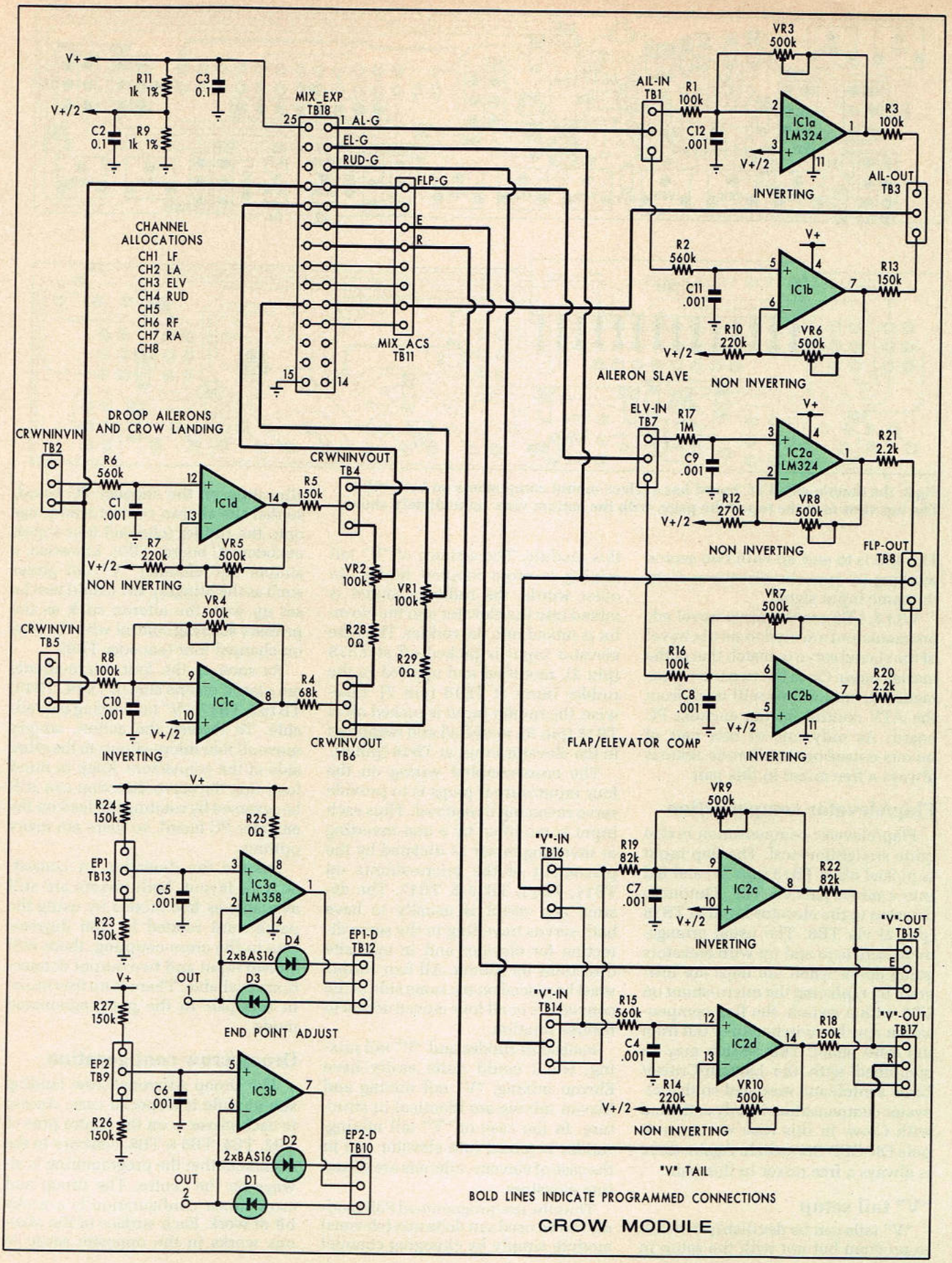
Last month I stated that in the Mk.22 F3B module, each pair of mixers share common input and output plugs and a consistent system has been adhered to in order to simplify programming. However, note that the Crow landing and "V"-tail mixers have four plugs that are cross-coupled. This deviation was called for in order to simplify the pre-programming and setup of servo directions.

In general, the lefthand trimpot is the inverting mixer gain control and the righthand trimpot is the non-inverting gain control. Input is always on the lefthand pair of 3-pin plugs and output on the right and the non-inverting input/output pair of pins is always closest to the row of pots. Clockwise rotation always increases servo travel. VR1 & VR2 are exceptions due to the nature of their operation.

Aileron slave circuit

The aileron slave circuit is straightforward. The aileron input is picked off at TB18 (pin 1) and fed to a suitable mixer via TB1. The output is then taken to TB18 (pin 10) via TB3.

Fig.1: The F3B mixer module consists of a number of four pairs of inverting/non-inverting op amp mixers together with a pair of end-point adjust circuits (IC3a, IC3b) to limit servo travel.


V+
V+/2
R11 1k 1%
C3 0.1
C2 0.1
R9 1k 1%
MIX_EXP TB18
25
1 AL-G
EL-G
RUD-G
FLP-G
E
R
15
14
MIX_ACS TB11
CHANNEL ALLOCATIONS
CH1 LF
CH2 LA
CH3 ELV
CH4 RUD
CH5
CH6 RF
CH7 RA
CH8
AIL-IN TB1
R1 100k
C12 .001
VR3 500k
IC1a LM324
INVERTING
R3 100k
AIL-OUT TB3
R2 560k
C11 .001
IC1b
R13 150k
R10 220k
VR6 500k
AILERON SLAVE
NON INVERTING
DROOP AILERONS AND CROW LANDING
CRWNINVIN TB2
R6 560k
C1 .001
IC1d
CRWNINVOUT TB4
R5 150k
R7 220k
VR5 500k
NON INVERTING
VR2 100k
VR1 100k
VR4 500k
CRWINVIN TB5
R8 100k
C10 .001
IC1c
R28 0Ω
R29 0Ω
R4 68k
INVERTING
CRWINVOUT TB6
ELV-IN TB7
R17 1M
C9 .001
IC2a LM324
R21 2.2k
R12 270k
VR8 500k
NON INVERTING
FLP-OUT TB8
VR7 500k
R16 100k
C8 .001
IC2b
R20 2.2k
FLAP/ELEVATOR COMP
INVERTING
R24 150k
R25 0Ω
EP1 TB13
IC3a LM358
C5 .001
R23 150k
D4
2xBAS16
EP1-D TB12
OUT 1
D3
END POINT ADJUST
R27 150k
EP2 TB9
IC3b
C6 .001
R26 150k
D2
2xBAS16
EP2-D TB10
OUT 2
D1
"V"-IN TB16
VR9 500k
R19 82k
C7 .001
IC2c
R22 82k
INVERTING
"V"-OUT TB15
"V"-IN TB14
R15 560k
C4 .001
IC2d
R18 150k
"V"-OUT TB17
R14 220k
VR10 500k
NON INVERTING
"V" TAIL
BOLD LINES INDICATE PROGRAMMED CONNECTIONS

CROW MODULE

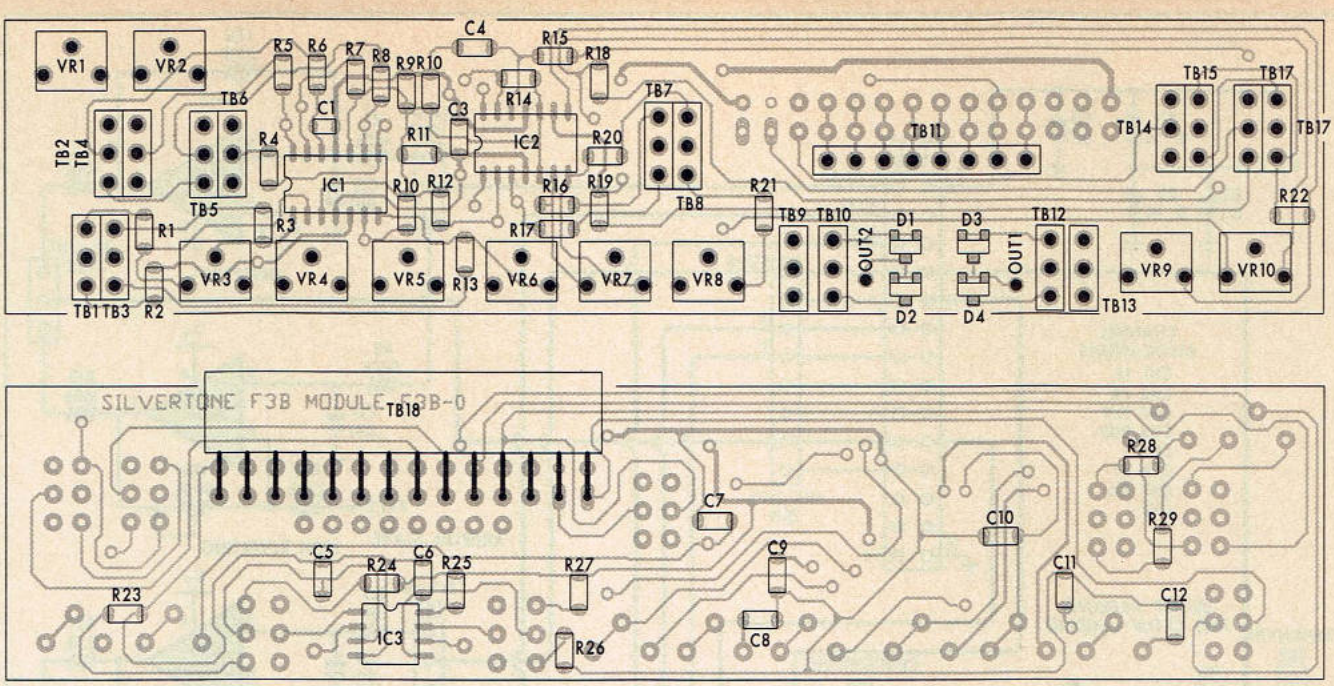


Fig.2: the double-sided PC board has surface mount components on both sides. The top view is at the top of the page, with the bottom view immediately above.

The aim is to end up with two servos working in opposite directions from the same input signal.

VR3 & VR6 are the servo travel adjustments and are used to set the travel of the slaved servo to match that of the master servo. Once the two travels are matched, both servos will track from the ATV control on the encoder PC board. As only one of this pair of mixers is used on the ailerons, there is always a free mixer in this pair.

Flap/elevator compensation

Flap/elevator compensation is also quite straightforward. The flap input is picked off at TB18 (pin 25) and fed into a mixer pair via TB7. Output is directed to the elevator input at TB18 (pin 2) via TB8. The usual arrangement here is to end up with elevators going down when the flaps are lowered. By replacing the micro-shunt on TB8 with a switch, the flap compensation may be switched in or out from the front panel. This switch may be combined with the Launch/Cruise/Crow switch and arranged so that elevator compensation is only activated with Crow. In this case we use a 4-pole ON-OFF-ON switch. Again, there is always a free mixer in this pair.

"V" tail setup

"V" tails can be devilishly difficult to program but not with the setup in this module. The essence of "V" tail mixing is cross-coupled inputs. In other words, the rudder channel is mixed into the elevator and the elevator is mixed into the rudder. Thus the elevator input is picked off at TB18 (pin 2), modified and applied to the rudder input at TB18 (pin 7). Likewise, the rudder input is picked off at TB18 (pin 3), modified and reapplied to the elevator input at TB18 (pin 6).

The cross-coupled wiring on the four input/output plugs is to provide servo reversing if required. Thus each input is modified by a non-inverting or inverting mixer as dictated by the placement of the micro-shunts on TB14, TB15, TB16 & TB17. The desired end result is usually to have both servos travelling in the same direction for elevator and in opposite directions for rudder. All four shunts must be placed on the same side of the connectors or all four moved across to reverse rotation.

Instead of rudder and "V" tail mixing, we it could quite easily have Elevon mixing; "V" tail mixing and Elevon mixing are identical in structure. In the case of "V" tail mixing, rudder is mixed into elevator and in the case of elevons, ailerons are mixed into elevators.

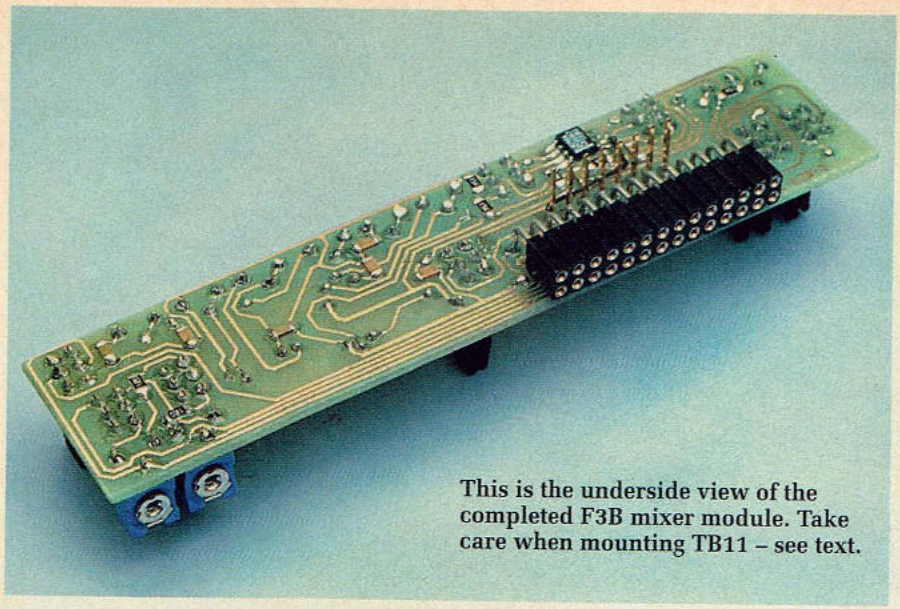
Thus the pre-programmed F3B module can be used as a delta mix (elevons) module simply by changing channel allocation on the encoder PC board, so that the aileron control lead plugs onto the rudder (channel four input, encoder PC board, TB9). Likewise, a simple two channel "V" tail glider such as the Stingray 2M would best be set up with the aileron stick as the primary steering control with the lead on channel four (encoder TB9).

As soon as the four micro-shunts are placed on one side of TB14, TB15, TB16 & TB17, "V" tail mixing is available. To reverse the action, simply move all four micro-shunts to the other side of the connectors. Keep in mind here that the servo direction can still be reversed by rotating the lead on the encoder PC board, so there are many options.

Despite the deviation in consistency of layout, both mixers are still available as free mixers by using the patch cord rotated by 180 degrees. Due to the cross-coupling, there will be two input and two output connections available. There is no free mixer in this pair in the pre-programmed mode.

Droop/crow configuration

The Droop Ailerons/Crow landing sub-module is a special case. Access to each mixer is on the centre pins of TB2, TB4, TB5 & TB6, contrary to the statement that the programming is always on the centre. The droop and crow mixer configuration is a tricky bit of work. Each surface of the ailerons works in the opposite sense in



This is the underside view of the completed F3B mixer module. Take care when mounting TB11 – see text.

that as one moves up the other goes down. Now to apply droop (both moving down simultaneously), one servo must be fed from a common point with a non-inverting input and the other with an inverting input.

However in the case of the Crow landing configuration both servos must go up simultaneously, exactly the opposite to that of droop. In other words, the servo that was fed an inverting input now receives a non-inverting input and vice-versa. So why not save a pair of mixers by simply reversing the inputs from the Droop configuration? This is exactly what is done in the Droop/Crow circuit.

If you now refer to the Fig.2, the component overlay for the PC board, you will notice that TB2 & TB4 are placed in the normal side-by-side arrangement and TB5 & TB6 are likewise. This allows the free mixer to be accessed with a patch cord from the centre of each pair of plugs. The cross coupling in this case is done with potentiometers VR1, VR2, with the mixing output coming from the wiper of each pot. R28 & R29 are simply zero ohm jumpers.

Switching is achieved by using an ON-OFF-ON double-pole switch wired to two standard servo plugs, one plugged onto the mixer outputs TB4 and one onto TB6; signal to the centre terminal in each case. Remember to keep the polarity of the plug the same on each mixer plug. The sense of operation of this switch may be reversed by rotating both plugs by 180°. This switch may be located on the front of the transmitter and becomes the Launch/Cruise/Crow master select switch. A micro-shunt placed on the input plugs TB2 & TB5 completes the programming of this sub-module.

Thus when the centre-off switch is in the middle position, there is no mixing applied to the ailerons. When Launch mode is selected, one mixer is connected to one end of VR2 and the other to one end of VR1. When Crow is selected, the order is reversed and the mixer connected to VR1 is connected to the other end of VR2 and vice-versa.

Thus VR1 & VR2 are balance pots which set the ratio of Crow to Droop signal applied to each aileron (approximately 80:20 - 20:80). VR4 & VR5 set the overall gain of the mixers (servo throw) and are also used to set the balance for each servo travel. Once the servo throws are equal, VR1 & VR2 distribute it to the servos in the correct proportions. The usual arrangement is have more Crow movement than Droop.

It soon becomes apparent that by removing the micro-shunts on the inputs of this mixer pair (TB2, TB5), the pre-programmed coupling with the flaps is removed and any other suitable source of control voltage may be substituted for the flap input. This voltage could come from switched pots, auxiliary levers or pots etc. As stated previously, only the imagination and level of understanding of the operator limit the Mk.22 system.

The same is usually true of the really smart computer systems, so take

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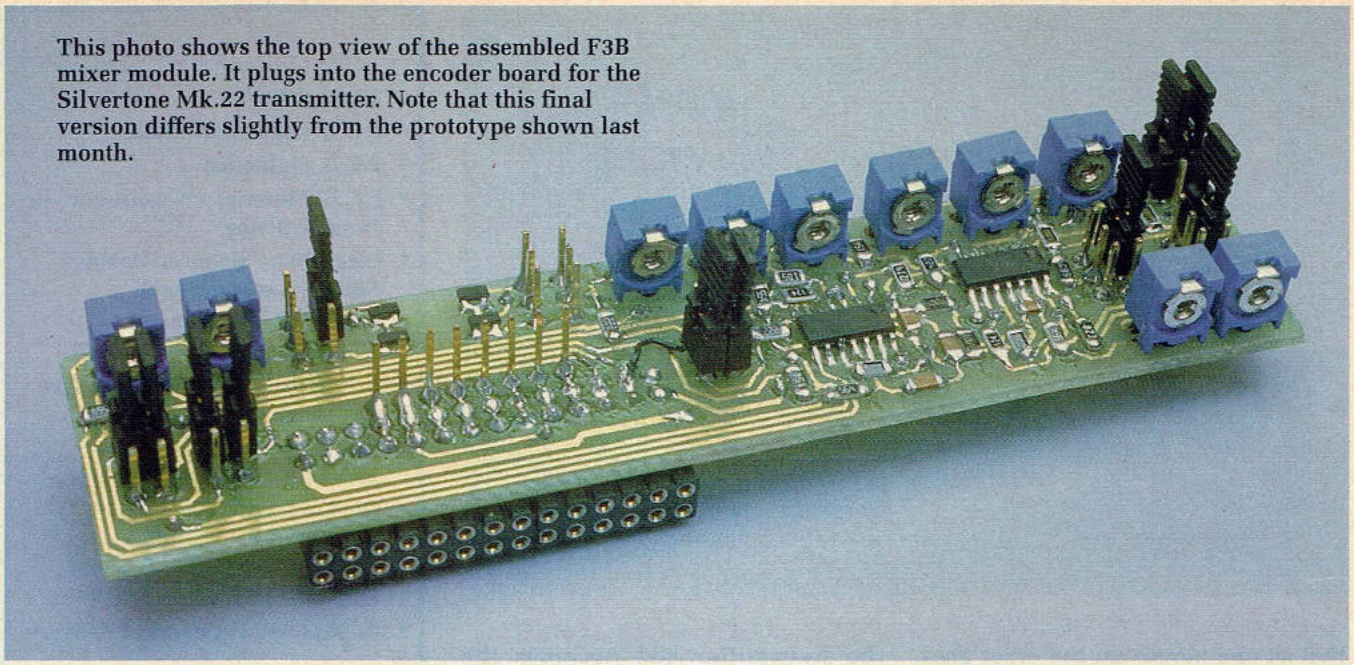

This photo shows the top view of the assembled F3B mixer module. It plugs into the encoder board for the Silvertone Mk.22 transmitter. Note that this final version differs slightly from the prototype shown last month.

the trouble to fully understand your system.

End point clamps

Using the flap lever to activate the Droop/Crow function in a half-rail encoder introduces some complications as unwanted mixing will be applied at the top end of the flap travel. To overcome this, we use an end-point clamp to set the neutral point (servo end travel) at the half-rail voltage. Thus if one of the auxiliary potentiometers is plugged onto TB9 or TB13, the auxiliary pot on the transmitter front panel can be used to set the flap position. In operation, the servo follows the flap lever until the end-point is reached and movement ceases.

Now this provides a very useful function in that wing camber is now directly controllable from the front panel in flight via the auxiliary pot. R23, R24 and R26, R27 are limit resistors and restrict the amount of camber variation available. The larger the values of the resistors, the smaller the camber change angle becomes. Thus camber can be set to suit the conditions of the day or during trimming of the model before transferring the values into set pots.

Diodes D1, D2 and D3, D4 reverse the end-point. By placing the micro-shunt on the appropriate half of TB10 or TB12, high end or low-end-point adjustment is available.

Out 1 and Out 2 are the patch plugs for the end-point clamps and are simply single header pins or may be hard wired into the circuit. These can go to any pin on TB11. If you are using them for aileron differential, one must go to each aileron input.

To use the F3B module on a Mk.22 transmitter, simply remove the existing eight micro-shunts from TB10 on the encoder PC board and plug in the module. Connect the appropriate switches and pots to the 3-pin plugs and you are ready to set servo directions. Place the micro-shunts on one half of the 3-pin plugs and switch on. To reverse the servo, simply move both micro-shunts to the other side of the 3-pin connectors. Adjust the servo throws and you are ready to fly; all very simple.

Assembly

Assembly is quite simple. As it is all in surface mount, it might pay to read "Working with Surface Mount Components", as featured in the January 1995 issue of SILICON CHIP, before you start.

Begin by mounting all the ICs, then do all of the smaller surface mount components, remembering that there are SMDs on both sides of the PC board. Next, mount the large connector TB18 on the side away from the ICs, followed by TB11. TB11 is a little tricky in that it protrudes an equal distance either side of the PC board. Be sure to use the long header pins provided for this connector. TB11 is the patch cord input and provides two inputs for each channel by virtue of the fact that there is sufficient length either side of the PC board to plug on a patch cord.

Next mount the header pins with the pins on the IC side of the board. Finally, mount the trimpots.

Assembly is completed by either wiring the end-point clamp(s) permanently into the appropriate channel(s) or making a small single pin patch cord for each channel. Do not forget the single header pin in each of the end-point out pads.

Acknowledgment: I would like to thank Dean Herbert of Microherb Electronics for his assistance with the end-point clamp.

Bob Young is the principal of Silvertone Electronics. Phone: (02) 9533 3517. Web-site: www.silvertone.com.au

Kit Availability

The F3B mixer module is priced as follows:

Fully assembled module $99.50
Complete kit with PC board .. $75.00
Double-sided PC board $19.50

Postage & packing for the above kits is $3.00. Payment may be made by Bankcard, cheque or money order to Silvertone Electronics. Send orders to Silvertone Electronics, PO Box 580, Riverwood, NSW 2210. Phone/fax (02) 9533 3517.

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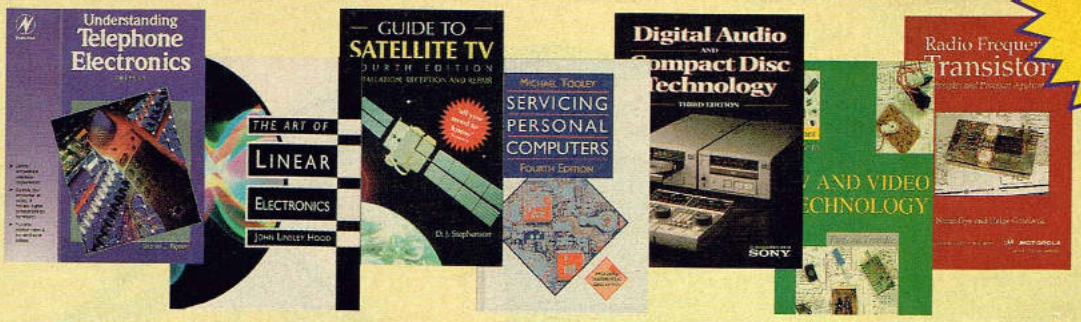

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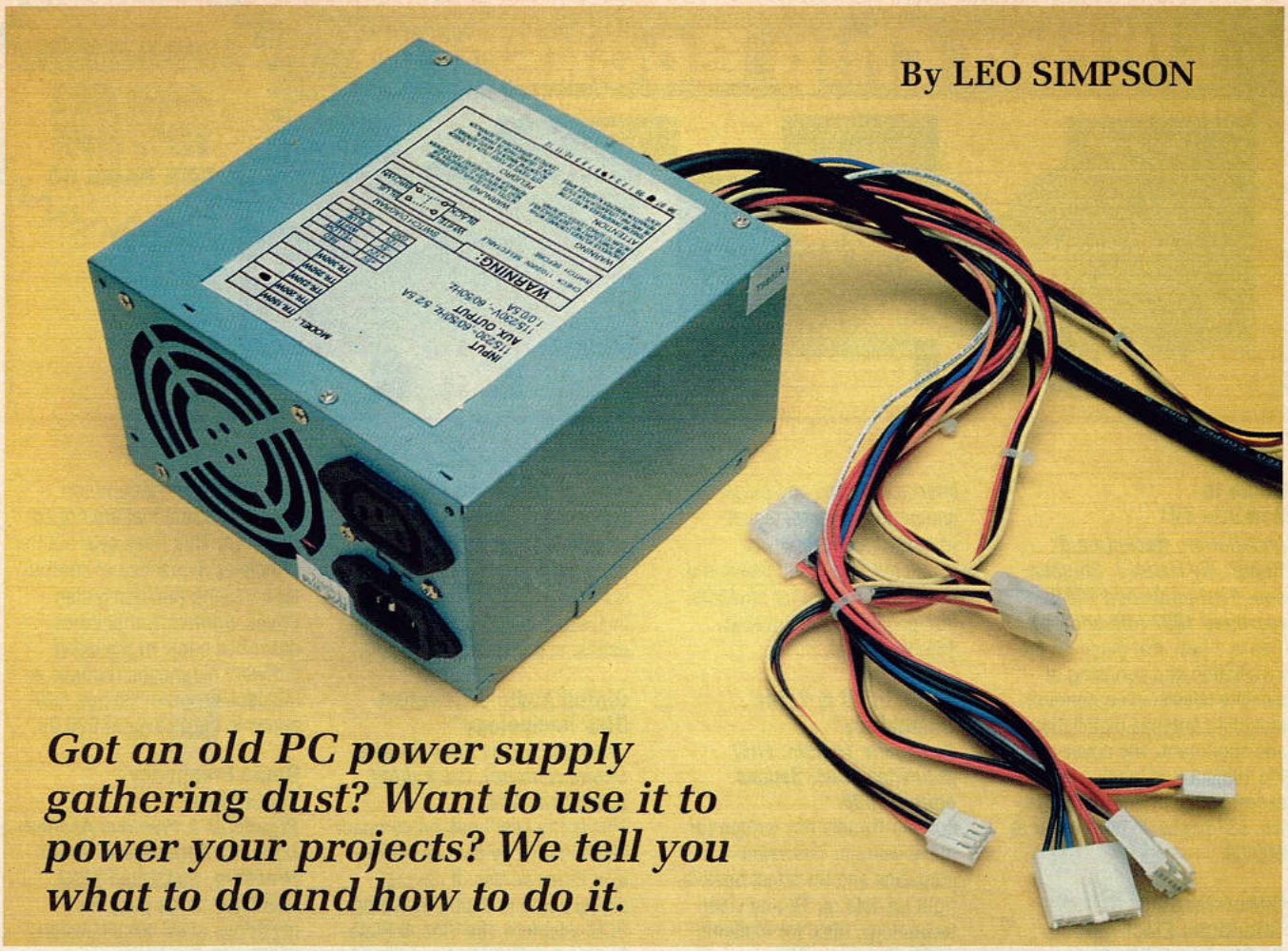


Got an old PC power supply gathering dust? Want to use it to power your projects? We tell you what to do and how to do it.

Use your old PC power supply for high current outputs

AS TIME GOES ON, more and more old computers are quietly gathering dust or worse, being thrown on to the tip. Often these are perfectly good machines which still function as well as the day they were purchased. But if you don't want to use them as computers you can still use their power supplies.

Computers have big power supplies in a small box. A typical older machine will have a 200W power supply capable of delivering +5V at 20A, +12V at 8A, -5V at 0.5A and -12V at 0.5A. You can use this power supply for all sorts of applications pretty well as it is, with no modifications required. And if you want, you can crank up the +12V output to get around +13V which is more appropriate if you want to power CB or amateur band equipment, audio equipment or bench test car projects. We'll talk more about this aspect later.

First, let's talk about the PC supply as it stands. Typically it is contained in a small folded metal box with an inbuilt 12V fan and two IEC power sockets, one male and one female. The male socket is for the mains input while the female socket is for the switched output to the video monitor.

This is a switched mode supply

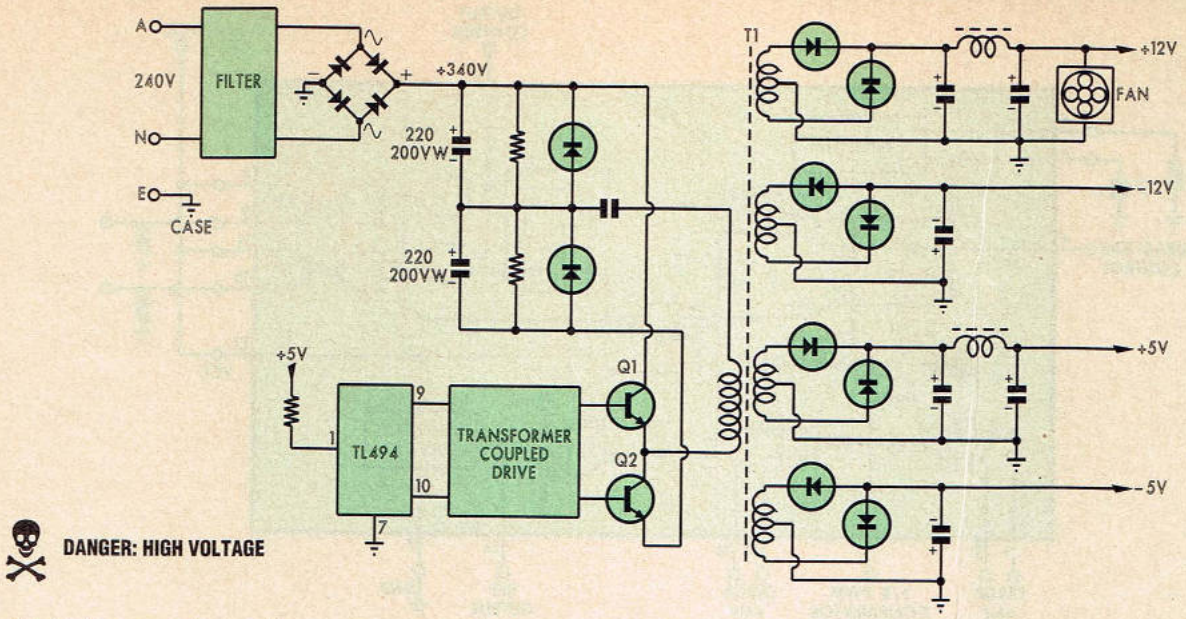


Fig.1: the general circuit arrangement inside most computer power supplies. The TL494 gives precise regulation of the main +5V rail and the other rails are unregulated. Note that all the circuitry on the primary side of the inverter transformer runs at around +340V and is also floating at around half the 240VAC. It is lethal if touched.

and typically uses a TL494 switchmode controller IC and a couple of transistors driving a transformer at around 40kHz or more to provide the four separate supply rails. Fig.1 shows the general arrangement. We must stress here that Fig.1 shows only the broad outline of the circuit and every one of these power supplies shows great differences in the detail of their circuits.

By the way, if you do manage to obtain the circuit of a computer power supply, you have rare treasure indeed. We have yet to see a full circuit and we understand that most serviceman do not have the benefit of circuits either.

Back to Fig.1: the mains supply comes in via a filter network and is fed to a bridge rectifier to produce around 340V DC. Interestingly, the filter capacitance is usually made up of two 200V capacitors connected in series across the 340V and they typically have a capacitance of around 220-330µF. Each of these capacitors generally has a diode and resistor across it to ensure that they share the total voltage of 340V equally.

The 340V DC is then fed to a switchmode circuit involving two transistors (or Mosfets) in a push-pull inverter transformer. By the way, considering the amount of power involved, the transformer is ridiculously small. It looks fairly conventional in construction but instead of using steel laminations it has a ferrite core which enables it to run with switching speeds of 40kHz or more. This enables a very small transformer instead of the very bulky and heavy unit which would be required if the transformer was running at 50Hz.

The transformer provides the full isolation between the 340V DC supply on the primary side and the low voltage supplies on the secondary side.

Note that all the circuitry on the primary side of the transformer is at mains potential and must be regarded as lethal.

On the output side, the transformer has at least four secondary windings, each centre-tapped. Each secondary feeds two high speed fast recovery diodes in a full-wave rectifier followed by a toroidal inductor and another filter capacitor. The diodes for the +5V and +12V rails are usually clamped to a finned heatsink. By the way, each pair of diodes are in a three-lead package which usually looks like a plastic power transistor.

Block diagram

Fig.2 is the block diagram of the TL494 switchmode controller used in most of these supplies. If yours does not use a TL494 you will probably find it has a Samsung KA7500B and guess what? It's identical in function and pin connections to the TL494.

This chip provides precise voltage regulation for the +5V rail only and the other supply rails depend on the basic regulation of the transformer for their performance. Typically, if you connect a 5A load across the +5V rail it will drop by only a few millivolts whereas if you connect a 5A load across the +12V rail it will drop by 0.5V or more. Even if you don't meas-

WARNING!

The internal wiring of switchmode computer power supplies is dangerous when powered up. Not only do you have bare 240VAC wiring to the IEC sockets but a good portion of the circuitry on the PC board is +340V DC floating at half the mains voltage. IT IS THEREFORE POTENTIALLY LETHAL!

Use extreme care if you do decide to make measurements on the supply when the case is open and DO NOT TOUCH ANY PART OF THE CIRCUIT when it is operating. Make sure that it is disconnected from the mains when you are making any modifications to the internal wiring.

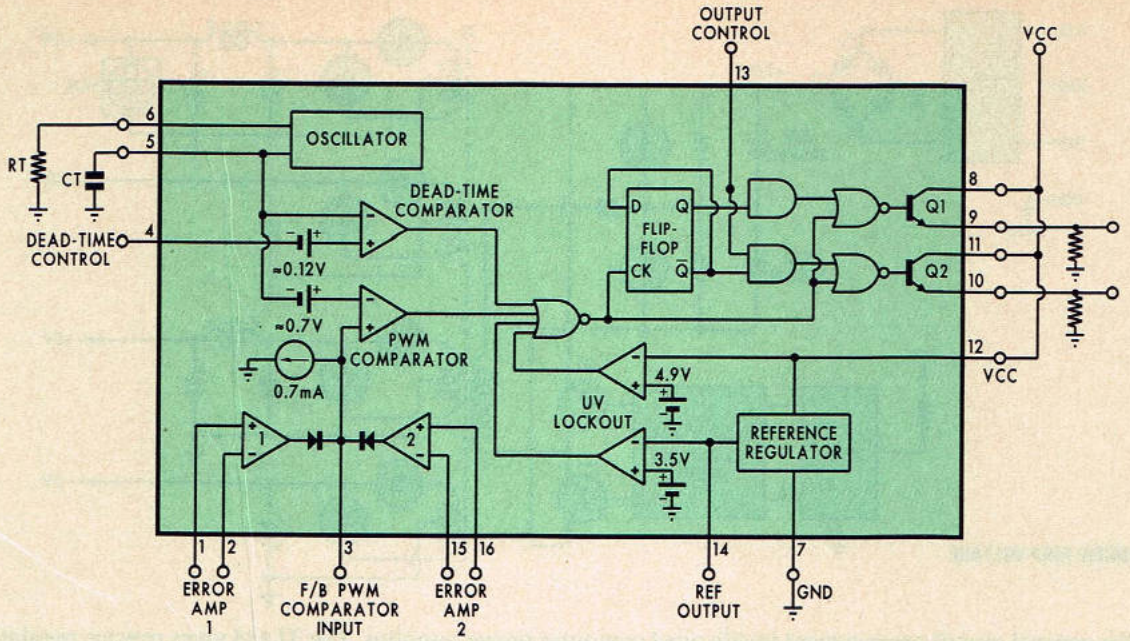


Fig.2: this is the schematic of the Texas Instruments TL494 and Samsung KA7500B switchmode controllers, used in the big majority of PC computer power supplies.

ure the +12V rail when you load it up, you will still know that the voltage has dropped a bit because the fan will sound a little slower.

By the way, when installed in a typical computer, the fan does double duty. Not only does it cool the switchmode power supply components, it also cools the componentry inside the case of the computer. But its most important job is to cool the power supply itself and so it should not be disconnected, even if your proposed application means that the supply will be lightly loaded most of the time.

Minimum load

While the TL494 provides very good regulation for the 5V rail, the supply needs a minimum load. If you disconnect all the supply leads from inside your computer and then turn it on, you will probably find that the power supply will not work at all and this is because it does not have a minimum load. How much load is required? Difficult to say really, but we have found that you typically need at least 100mA. That means you need a minimum load consisting of a 47Ω 1W resistor connected across the +5V output.

(Having said that, as part of the preparation for this article, we purchased a brand new computer supply and found that it did not need any minimum loading to make it work.)

The other supply rails do not need any loading to make them work but you will generally improve their regulation if you do connect some minimum load across them. The +12V rail already has a load because of the 12V fan but you can improve the regulation by pulling another 100mA or so; use a 100Ω 5W resistor. For the -12V and -5V rails, try a minimum load of around 10mA; use a 1kΩ 0.25W resistor across the -12V and a 470Ω 0.25W resistor across the -5V rail.

Regulation explained

How does a minimum load make the supply regulation better? To explain that we should first discuss what we mean by the term regulation. There are two types of regulation: load and line. Load regulation refers to how the output voltage varies between the "no-load" condition and "full load" and is usually referred to as a percentage.

For example, in a typical computer power supply in which the +5V rail can supply up to 20A, the no-load voltage would typically be very close to +5V (eg, 5.02V) and might drop to 4.88V at 20A. The difference in the two voltages is 140mV (5.02 - 4.88 = 140mV) and when divided by the no-load voltage of 5.02V, the percentage becomes 2.8% which is pretty good.

Since the other supply rails are not regulated (ie, directly controlled by the TL494), their regulation is not as good and will typically be around 6-10% at full load.

Line regulation refers to the change in output voltage as the input voltage (ie, the mains supply) is varied. Computer switchmode supplies are really excellent in this respect since the nominal input supply range is typically 115V to 230V. In practice, the mains voltage can be varied from less than 110V to more than 250VAC while the +5V rail stays rock steady.

In this respect the switchmode power supplies in computers are vastly superior to any conventional linear regulated supply and they are a great deal more efficient, as well.

To answer the question as to how a low level of loading can improve regulation, the main factor is the voltage drop across the diodes. When the supply loading is zero or minimal, the voltage drop across the rectifier diodes becomes quite low, possibly less than 0.5V. But when the supply is loaded up, the voltage drop across the diodes increases to as much as 1V and then stays more or less constant, regardless of increasing current.

This minimises the diode voltage drop as a factor in the output regulation and the result is improved performance.

Mind you, there is a trade-off and any increase in load leads to an in-

crease in power supply ripple and hash.

Lead colour coding

This talk of regulation and minimum loading is all very well but how do you identify which output wire is which and how do you make the connections? When you look at one of these supplies you will find that there is a veritable festoon of wires coming out of it, all terminating in multiple four and six-way plugs of various sizes and configuration. So you don't just have one really heavy gauge wire coming out for the +5V output; there are multiple 5V wires.

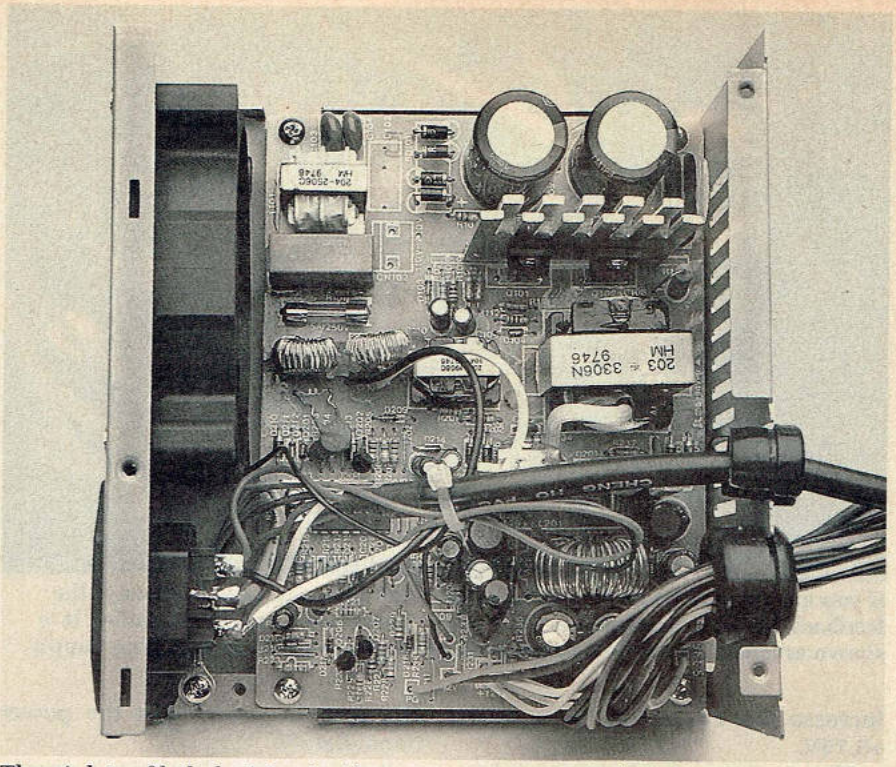
Happily there is a consensus on the colour coding and it is generally as follows: +5V red; +12V yellow; -12V blue; -5V white and common (0V) black. There may also be an orange lead which is the Power Good (PG) signal wire.

Now if you want to use the supply to provide +12V at 8A, for example, you really need to connect all the yellow wires in parallel to your output. If you try to pull 8A from just one of the yellow wires, you will find that the output regulation is not as good as it could be and in an extreme case, you could end up melting the wire insulation; so connect 'em up in parallel and the same comment goes for the black (0V) wires.

Powering op amps

Now while the thrust of this article has been about using the +12V rail to power equipment in a variety of situations, these computer power supplies can also be used to power audio equipment which requires balanced ±15V supplies, most of which employs op amps which are not critical as far as regulation is concerned. Therefore you can use the +12V and -12V rails to power equipment where ±15V is normally required.

There is a proviso here and that is that the -12V rail usually can only supply up to 0.5A. Another factor which must be considered in all of this is that computer supplies have switching hash superimposed on their outputs and this could be a problem if you are using it to power sensitive audio equipment. On the other hand, if the equipment has onboard regulators, the problem is solved. Remember that sound cards in computers do have sensitive low level analog circuitry and they cope with the hash situation pretty well.



There's lots of lethal wiring inside every computer switchmode power supply. In particular note the bare wires to the IEC power sockets (240VAC) and all the circuitry above the transformer in this picture which sits at around 340V DC and at half mains potential. Do not touch any part of the circuit while it is operating.

And what about the main +5V rail? What can you use that for? This question has us stumped. Perhaps some of our readers can make a few suggestions. Keep them clean please.

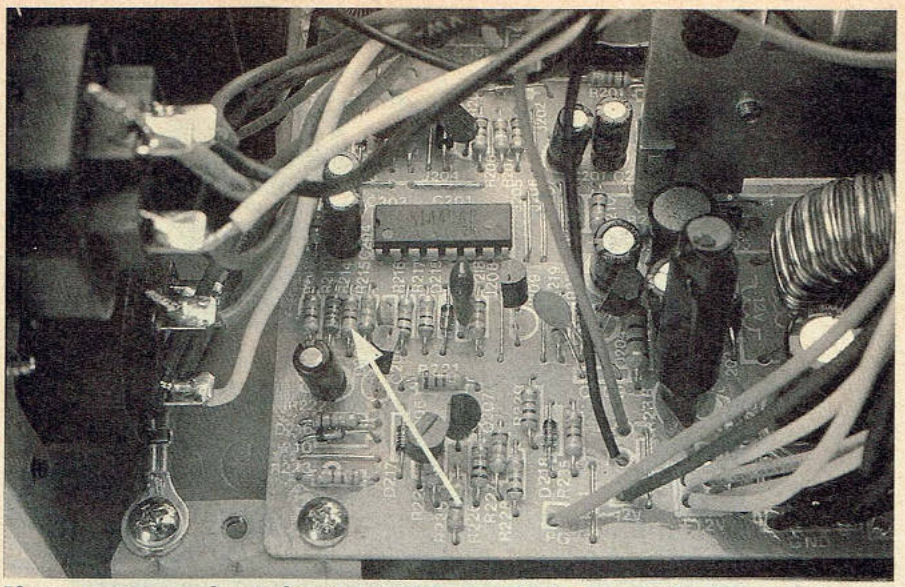
Boosting the output

So far we have discussed using a computer power supply just as it comes but a lot of 12V equipment for use in cars, particularly CB radios, amateur transceivers and audio equipment, performs considerably better if the supply is increased to around +13.6V DC. In fact, a lot of nominal 12V equipment is performance-rated at 13.6V or 13.8V. Can the computer supply be tweaked to deliver this? The answer is maybe. Some supplies can be made to go that high and others wimp out before they get there.

To make the supply deliver more than 12V you need to open up the case and here we must stress that this is dangerous territory indeed. Not only do you have bare 240VAC wiring to the IEC sockets but a good portion of the circuitry on the PC board is +340V DC floating at half the mains voltage. You have been warned. Once you open the case, you have a lethal supply.

With the warning out of the way, how do you go about making the supply deliver more than 12V? The answer is to tweak the feedback circuit to the TL494 which monitors the +5V rail. First, you must identify the feedback resistor which connects to pin 1 of the TL494 as this is almost always the op amp input used for this purpose. To make the identification, make sure that the power supply is disconnected from the 240VAC mains. Then switch your multimeter to its lowest "ohms" range or the audible continuity test and find out which resistor adjacent to pin 1 is actually connected to pin 1. You must find the resistor pigtail which is a short circuit to pin 1.

Now before you go any further, you might have struck it lucky and you may find that also close to pin 1 of the TL494 is a small trimpot. Bingo! You can tweak that to increase the +12V supply. Remember here that you will actually be increasing the +5V rail and all the other DC rails will increase in the same proportion. If you want to get to +13.8V you will need to



If you are going to boost the output of the +12V rail, you need to identify the feedback resistor connected to pin 1 of the TL494 switchmode controller. It is shown arrowed here but you have to go through the exercise with your supply.

increase the 5V rail by 15% or to +5.75V.

That is quite a big increase and in practice, some supplies cannot be pushed that far; they will get to around +5.5V and then audibly "squeal", possibly because of an overvoltage protection circuit. If that happens, back off on the adjustment until it settles down. Even so, you should be able to get more than 13V on the +12V output.

Making the adjustment

Adjusting the trimpot while the supply is powered and with the case open is a dangerous procedure because you will almost certainly find that the trimpot is right underneath the 240VAC wires to the IEC sockets. You can do the adjustment but you will need an electrician's Phillips head screwdriver with a completely insulated shaft. We used an electrician's screwdriver with a label rating of 1000V. Don't even think of using an ordinary screwdriver – we don't want to lose any readers!

To make the adjustment, connect your minimum load to the +5V rail. We used a 12V 50W halogen lamp as it could easily be plugged into one of the output sockets. Connect your multimeter to measure the +5V rail or the 12V rail.

Make sure you have someone with you when you do the adjustment. If the worst comes to the worst, and you get an electric shock, you want someone next to you to kill the power immediately.

Position your electrician's screwdriver in the trimpot and have your companion switch on the power. Rotate the trimpot in the direction to increase the supply as desired. Note that the fan will become louder as the +12V rail increases. When satisfied that the adjustment is what you want, have your companion switch off the supply, unplug it from the mains and then replace the lid.

Finding the feedback resistor

Back to the continuity testing: if your power supply does not have a trimpot you still have to find the 5V feedback resistor. Having found the end that connects to pin 1 of the TL494, now check whether the other end connects to the +5V output. You can do this by connecting one of your meter prods to a red wire in one of the multiway output plugs. Again, you should have a short circuit between the red +5V wire at one end and the +5V end of the feedback resistor.

Once you have clearly identified the resistor in question, you can measure its value. More often than not you will find that it is labelled 4.7kΩ but will measure half that value. That means that another resistor is shunting it somewhere in the circuit. Now it is unlikely that you will want to trace the circuit out but you don't have to do it anyway. All you have to do is to increase the resistance of the identified feedback resistor.

Unfortunately, to do this, you have to gain access to the underside of the PC board. Remove the four screws securing the board inside the case and then you can manoeuvre it to access the underside. Unsolder one end of the resistor and then solder a 560Ω resistor in series with it. That done, replace the PC board and the four screws. Be warned: don't take a shortcut and just sit the board back where it was without fitting the screws. If you do that, there is the danger of a short circuit underneath when you turn it back on and the whole power supply could be destroyed.

When you turn the supply on, measure the +5V and +12V rails and note the increase. If the +12V rail is now over +13V, you probably have gone far enough. If not, note the increase in voltage and then calculate the required additional series feedback resistor to get the increase you want.

Current rating

There are a couple of other points we need to make concerning this boosting of the +12V rail. While you can increase the voltage, you cannot increase the overall power output. Any increase in voltage must result in a proportional decrease in current. So if your supply is rated +12V at 8A and you increase it to +13.6V, the overall current will be reduced to around 7A.

Remember also that none of the DC outputs has any short circuit protection so if you overload the supply, you are liable to damage it. For that reason you cannot use the supply for battery charging unless you put in a suitable current limiting resistor.

On/off switch

If you want to remove the power supply from the computer case, you will no doubt want to change the on/off switch which is normally on the computer's front panel. Very old computers had their power switch on the back of the supply.

An easy way of installing a power switch would be to remove the IEC female socket and install a large illuminated rocker switch instead. Most of these switches snap into a standard cutout and a little work with a file or a chassis nibbler will do the trick. However, make sure that there are no metal particles floating around inside the case when you have finished. **SC**

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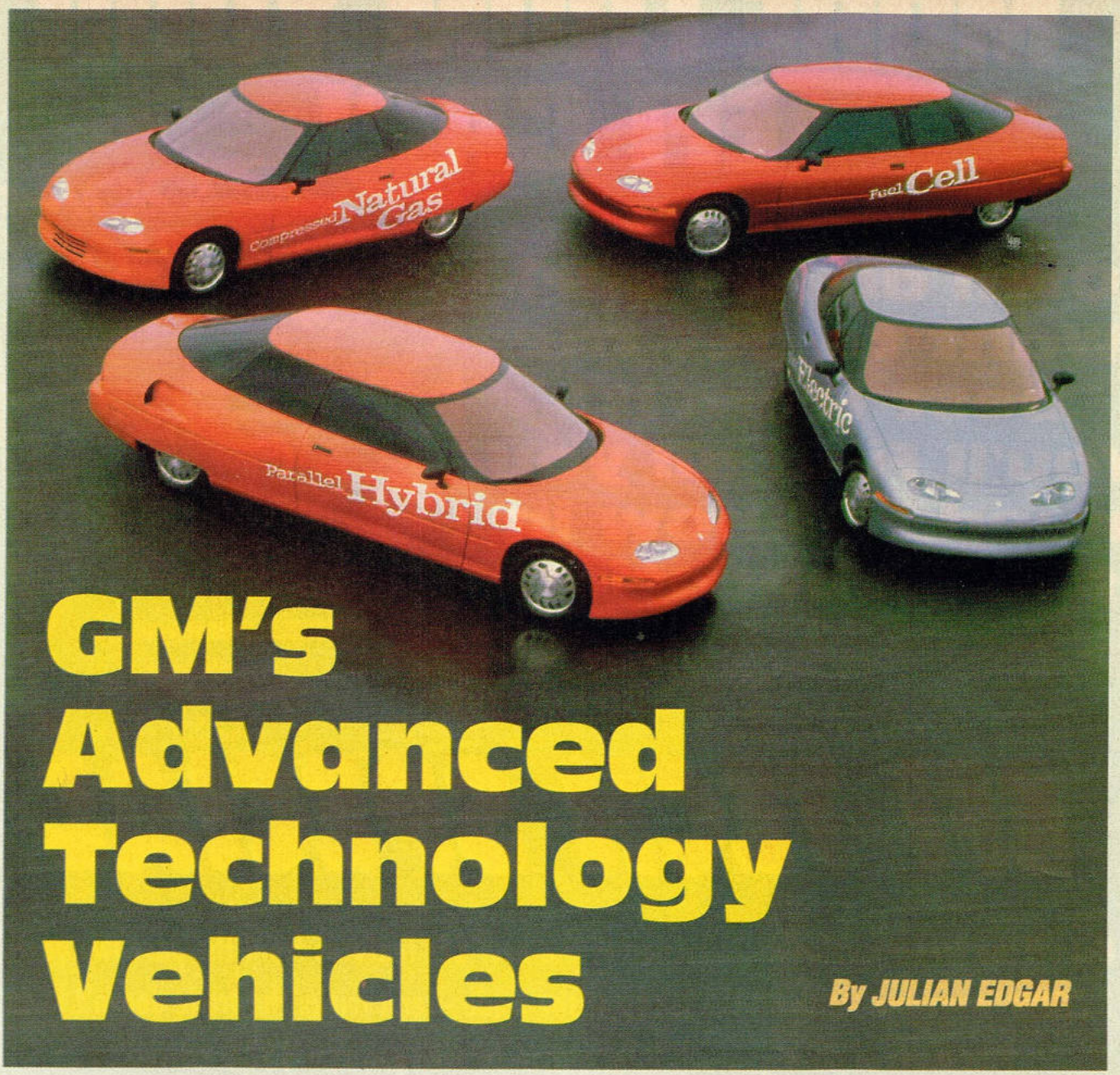


GM's Advanced Technology Vehicles

By JULIAN EDGAR

Joining GM's EV1 electric car is a range of other vehicles developed from the same basic platform. These new vehicles could well indicate your motoring future but which one will win out?

EARLIER THIS YEAR, General Motors in the United States introduced a series of new prototype cars based on the EV1 – the world's first commercially available purpose-designed electric passenger car. The new vehicles include three hybrid-powered cars and a vehicle fuelled by compressed natural gas (CNG).

In greater detail, the three new hybrid powered cars include a parallel hybrid electric, a series hybrid electric and a fuel cell electric. These vehicles were developed to overcome one of the main limitations of pure battery electric vehicles – poor range. We'll take a look at each of the new vehicles in turn, starting with the parallel hybrid electric car – see photo.

Parallel Hybrid Electric

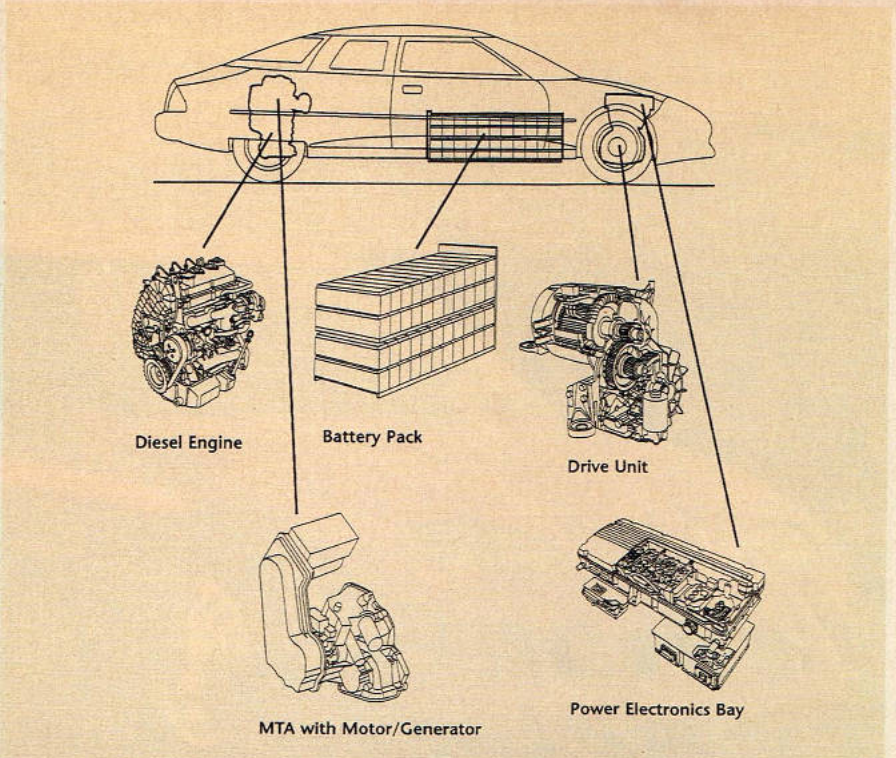
In addition to a battery pack, the Parallel Hybrid Electric car also uses a diesel engine which, as the name suggests, can be used in parallel with the electric motor. The vehicle weighs 1450kg and is based on a standard EV1, with the aluminium space-frame, front suspension and AC induction motor propulsion system generally unmodified. However, the car's wheel-

base has been increased by 48.3cm to provide greater interior space and a longer central tunnel for storage.

Instead of the T-shaped battery pack used in the EV1, the Parallel Hybrid uses 44 nickel metal hydride (NiMH) batteries wired in series and mounted in-line down the centre of the car. This gives room for the second propulsion system, which is mounted at the rear of the vehicle.

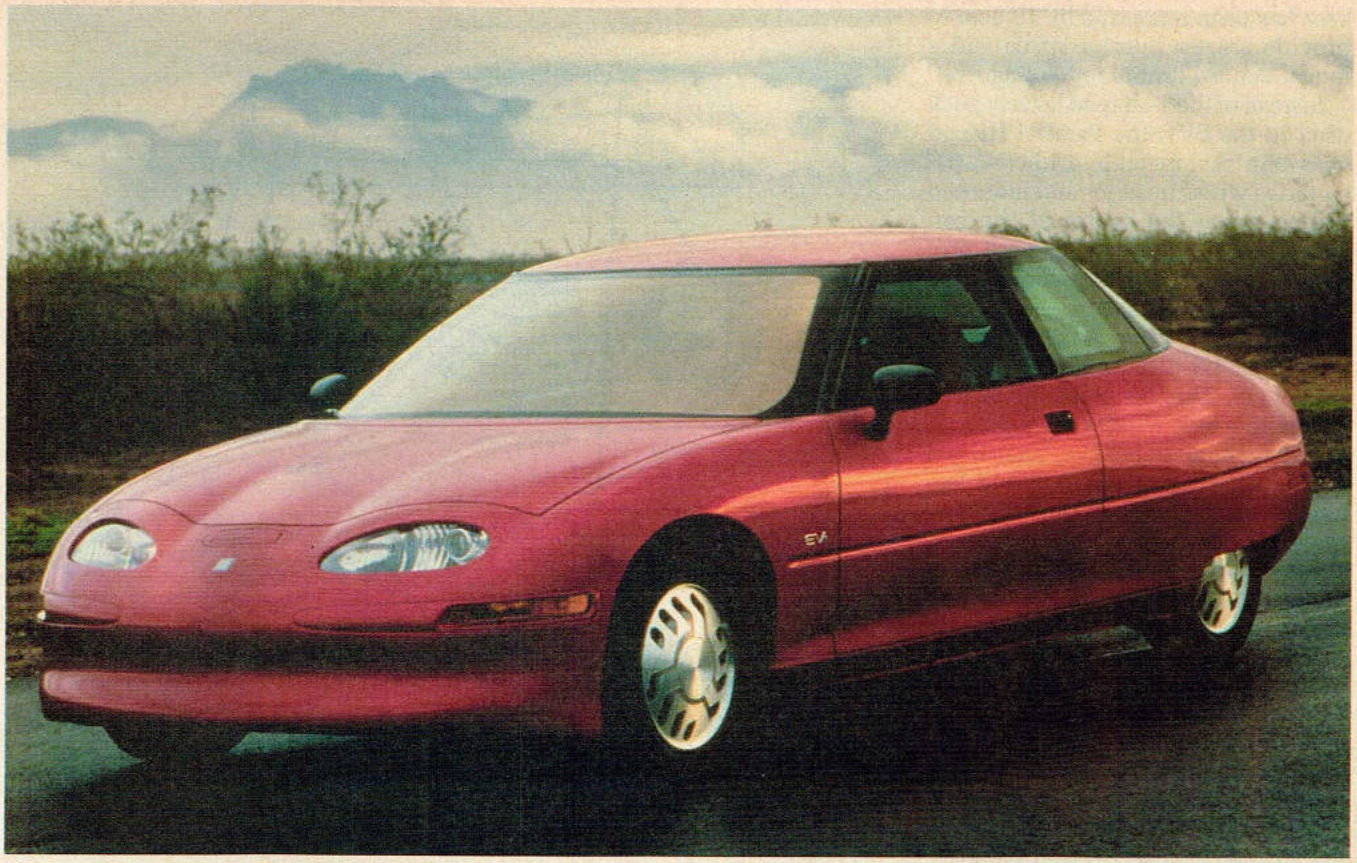
At the back of the car sits an Isuzu 3-cylinder 1.3-litre turbocharged diesel engine. This develops 56kW and drives the rear wheels through a 5-speed manual transaxle. The diesel engine uses direct injection and features double overhead camshafts. The transaxle, developed by Opel, uses electronically controlled servos to provide fully automatic gear selection and clutch engagement.

In addition to powering the rear wheels, the diesel engine also drives a 4.9kW permanent magnet DC brushless motor/generator unit. This motor/generator serves four purposes: it is used as a starter motor for the diesel engine; it provides regenerative braking through the rear wheels; it is powered by the battery pack to provide supplementary power for maximum acceleration; and it acts as an alternator to recharge the battery pack. It just

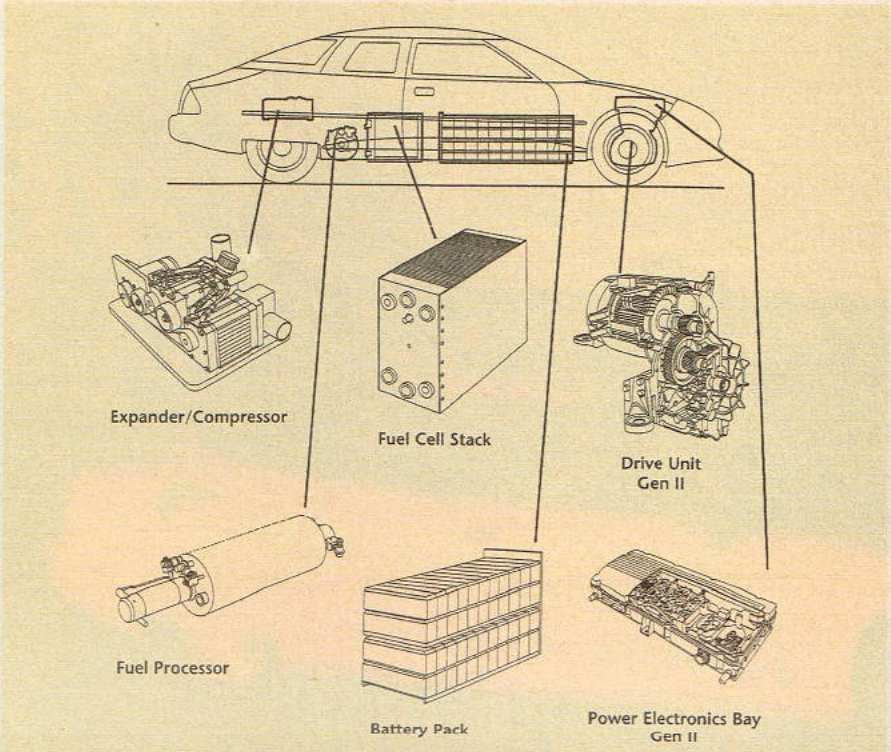


Parallel Hybrid Electric Vehicle

ABOVE & BELOW: the Parallel Hybrid Electric vehicle uses a 3-cylinder 1.3-litre turbocharged diesel engine plus a battery pack consisting of Nickel Metal Hydride (NiMH) batteries. When full power is required, 163kW can be mustered by simultaneous use of the diesel engine, a front-mounted electric motor and a rear motor/generator unit.



ABOVE & BELOW: the Fuel Cell Electric vehicle uses a battery of fuel cells supplied with hydrogen and oxygen, as well as a battery pack. The 1377kg vehicle has a range of 480km, can accelerate to 100km/h in about 9 seconds and has a petrol-equivalent economy of about 3 litres/100km.



Fuel Cell Electric Vehicle

doesn't do all of these things at once!

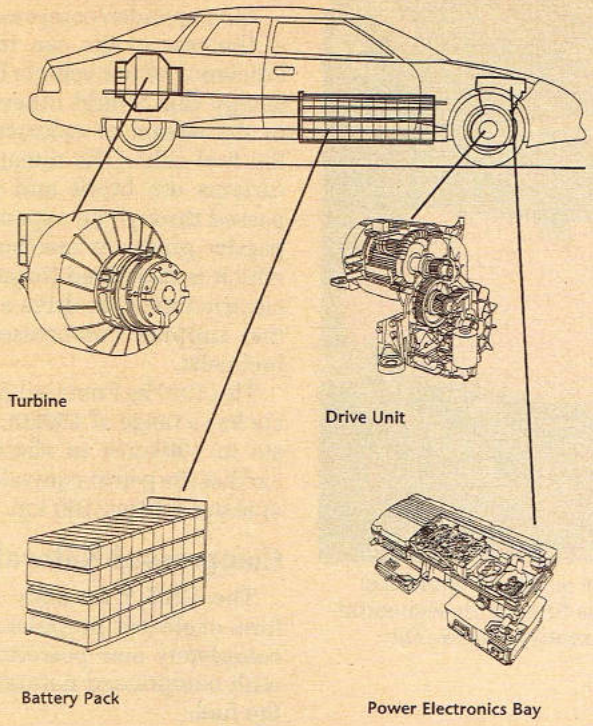
In the standard hybrid mode, the car moves off from a stop using the electric motor to drive the front wheels. If battery charge falls below a nominal 80%, the diesel engine starts, recharging the battery pack. In slippery conditions, the power sources at each end of the car can provide 4-wheel drive – leading GM to state that the Parallel Hybrid Electric is the world's first environmentally conscious all-wheel-drive performance car!

When full power is required, a not-inconsiderable 163kW can be mustered by the simultaneous use of the diesel engine, the front-mounted electric motor and the rear motor/generator unit. When driven flat out, the vehicle can accelerate to 100km/h in around 7 seconds. This represents outstanding performance!

The range of the car in full hybrid mode is quoted as 880km, while in "Zero Emission Vehicle" mode (ie, with the diesel engine not running) the car can travel 50km. Its fuel economy is about 3 litres/100km.

Series Hybrid Electric

In many ways the Series Hybrid



Series Hybrid Electric Vehicle

Electric vehicle is very similar to the car discussed above. However, instead of a diesel engine, this car has a gas-turbine engine tucked in the tail!

The gas turbine engine drives an electric generator and this works with an NiMH battery pack to provide the motive power. The turbine is the product of a three-year collaboration between GM and Williams International, an aerospace turbine engine manufacturer based in Michigan. Dubbed the "Auxiliary Power Unit" (APU), the device consists of a single stage, single shaft, recuperated gas-turbine engine coupled to a high-speed permanent magnet AC generator.

The cylinder-shaped APU has a mass of 100kg and is 50cm in diameter and 55cm long. Running at shaft speeds of between 100,000rpm and 140,000 rpm, it can develop up to 40kW of electrical power. This is sufficient to power the car's electric drive system and accessories, and/or charge its batteries while travelling at speeds of up to 130km/h. The turbine is fuelled with "reformulated" petrol.

In daily hybrid-mode use, the APU automatically starts charging the battery whenever its charge drops below 40%. If the vehicle were to be driven solely on a fully recharged battery pack, the APU would start after about 40km.

The series nature of the propulsion system allows the driver to select from either a 560km range of hybrid travel or up to 65km of electric-only travel. Flicking a single switch makes this choice. The 1340kg car has a maximum power of 102kW and can accelerate to 100km/h in around 9 seconds. Its fuel economy is about 4 litres/100km.

Fuel Cell Electric

The Fuel Cell vehicle uses one device to drive the front wheels and multiple sources of power for that device.

The driving device is the 102kW, 3-phase, AC induction motor from the EV1. It drives through a single-speed, dual-reduction gear-set with a ratio of 10.946:1. The battery pack consists of 44 NiMH battery modules connected in series and mounted in-line down the centre of the car. This pack can be recharged from the domestic supply to augment the power provided by the fuel cells. It is also used during regenerative braking.

As in a conventional battery, a fuel

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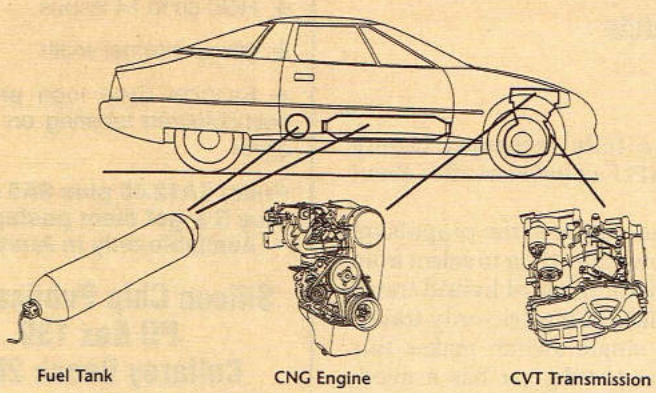
The Compressed Natural Gas (CNG) vehicle does not use any form of electric propulsion. Instead, a modified 3-cylinder Suzuki engine fitted with sequential port injection and a turbocharger is used to provide the motive power. The vehicle's range on full tanks of CNG is about 650km.



Compressed Natural Gas Vehicle

cell utilises chemical reactions at its electrodes to convert energy from chemical to electrical form. Unlike a battery however, a fuel cell stores the reactants separately from the electrodes, feeding them instead to the cell as "fuel" for the reaction.

In simple terms, a fuel cell consists of two electrodes separated by a membrane that conducts hydrogen ions but not electrons. Electrical power is generated by the reaction to hydrogen at one electrode to form hydrogen ions. The hydrogen ions migrate through the membrane and combine with oxygen at the other electrode to form water.

When hydrogen and oxygen are fed into the cell, an open-circuit voltage of about 1 volt (1V) is created between the electrodes. As power is drawn from the cell, the voltage drops slightly. To minimise this voltage drop, the electrodes are coated with minute quantities of platinum. The fuel cell stack consists of many individual cells sandwiched together and wired in series.

In this case, the GM car uses a multi-stage fuel processor to generate a hydrogen-rich mixture from methanol. Methanol was chosen because it is an ideal source of the hydrogen needed and it has fewer impurities than petrol or other hydrocarbon fuels.

An expander/compressor, located at the rear of the car, improves the efficiency of the vehicle by capturing energy that would otherwise be lost in the stream of exhaust gases from the fuel cells. The remaining hydrocarbons are burnt and the hot gas passed through an expander. The expander produces mechanical energy which is then used (together with an electric motor) to drive a compressor that supplies compressed air to the fuel cells.

The 1377kg Fuel Cell Electric vehicle has a range of 480km, can accelerate to 100km/h in about 9 seconds and has the petrol-equivalent economy of about 3 litres/100 km.

Compressed Natural Gas

The CNG EV1 does not use any form of electric propulsion. Instead, a completely new powertrain is fitted, with compressed natural gas used as the fuel.

The motive power consists of a 1-litre, 3-cylinder, sequential port injected, turbocharged engine developing 54kW at 5500 rpm. Modified from an existing Suzuki engine, the design uses an all-alloy construction, single overhead camshaft and two valves per cylinder.

The engine drives the front wheels through a Continuously Variable Transmission (CVT), which uses a steel belt and two V-shaped pulleys. This gives stepless power delivery and excellent fuel efficiency.

The fuel supply system uses two CNG tanks with a total useable capacity of about 38 litres. One tank is positioned longitudinally in the central tunnel, while the other is positioned laterally behind the rear seats. The tanks and their internal plumbing are designed for a maximum operating pressure of 3000 psi, with a single stage regulator lowering the pressure to 75 psi before injection occurs. As a safety measure, the system uses in-tank solenoids which are interlocked with the ignition system. These solenoids shut off the fuel during refilling and when the engine is not operating.

A special commercial station can refuel the CNG EV1 in 3.5 minutes, while a domestic compressor allows overnight fuelling. The CNG car has a range of 650km, a petrol equivalent economy of 4 litres/100km and a 0-100km/h time of 11 seconds. **SC**

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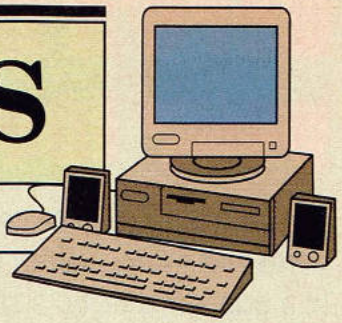
COMPUTER BITS

BY GREG SWAIN



Buying a PC isn't always hassle-free

There's lots of room for misunderstandings in the computer industry. Often, it's the customer's lack of expertise that causes the problems but sometimes it's the dealer who is at fault.

If anyone asks me for advice on buying a PC, I always tell them to choose the retailer carefully. Why? – because my own experiences with PCs from several retailers haven't been all that good.

Admittedly, some of the problems are fairly trivial and easily fixed if you have any technical ability. But why should you have to fix problems on a computer that's fresh out of the box? And if you don't have any technical ability, taking the machine back under warranty can be downright inconvenient.

Falling into the trivial (but inconvenient) category is the recent experience of a near neighbour. He was keen to buy a new PC and, having done his homework, ordered a Pentium II 333MHz machine with 32MB of RAM, a 17-inch monitor and Windows 98.

Unfortunately, things didn't go exactly according to plan. Oh, he got the machine OK within a few days of ordering it but when I asked him a week later if he was happy with his new toy, I was told that it didn't work. Pressed further, he explained that when ever he attempted to boot the machine, it would come up with a dialog box which stated that the mouse couldn't be found. The machine would then hang and refuse to complete the boot sequence.

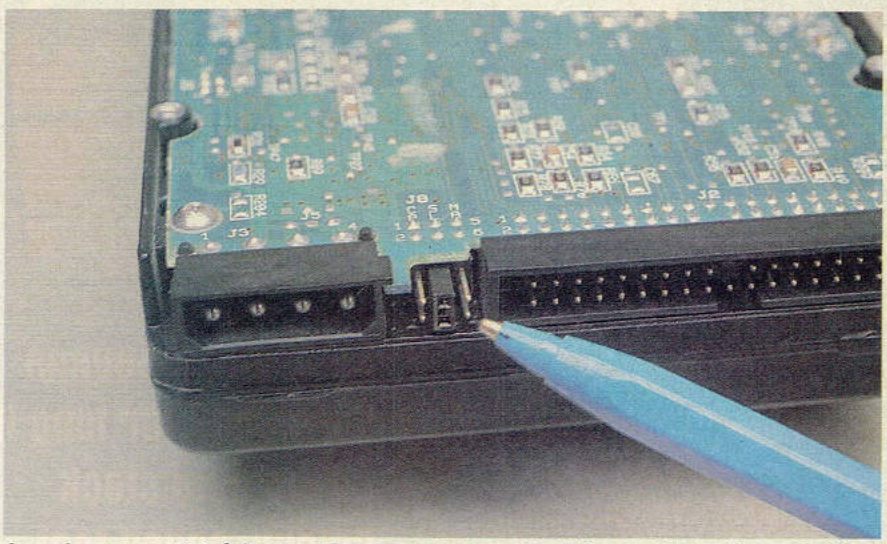
But that wasn't the end of the story. Apparently, he had ordered a Microsoft Intellimouse with the machine but the vendor didn't have one in stock and had substituted a Logitech mouse instead. And when he had rung to complain that the computer couldn't "find" the mouse, he was told that a Microsoft mouse driver had probably been installed and that this was causing the problems. All he had to do was install the correct Logitech mouse driver and all would be OK.

Unfortunately, he didn't know how to go about this, particularly as the machine wouldn't boot up in the first place. As far as he was concerned, he would have to make a special trip back to the vendor to get the situation resolved.

I must confess that I was rather puzzled by the symptoms. Simply changing the mouse shouldn't bother the operating system. Normally, if new hardware is connected, Windows 98 detects it during boot-up and prompts you to insert the Windows 98 CD-ROM (or a disc supplied with the device) so that the appropriate driver can be installed. After that, it should complete the boot sequence.

Curious about the symptoms, I volunteered to have a look at the machine for him. Maybe we could get it working with my Microsoft mouse and sort things out from there.

As it turned out, the problem was fairly straightforward. After following a couple of false trails, I eventually discovered that the keyboard wasn't working either. Further inspec-



If you have two IDE drives on the same port, one must be configured as a master and the other as a slave (unless you are using cable select). This is done using jumpers which are usually located at one end of the drive. A label on the top of the drive or near the jumpers shows the various options.

tion revealed that both the mouse and the keyboard were fitted with PS/2 connectors but the sockets they were plugged into were unlabelled. A quick check in the motherboard manual revealed that my neighbour had transposed the connections, plugging the mouse into the keyboard port and vice versa.

Swapping the connections over solved all our problems, the machine now booting normally into Windows 98.

So the dealer hadn't really done anything wrong and the substituted mouse had only served to confuse the issue. But how was my neighbour supposed to know which PS/2 port was which? Clearly, a couple of 5-cent labels would have saved him a great deal of time and frustration.

The NT machine

My next story concerns a machine that was bought by a friend from a local retailer for use in a small business that he owns. This was quite a well-specified machine that came with Windows NT Workstation, a 300MHz Pentium II processor and 128MB of RAM. And there were lots of other goodies as well, including a 6.4GB IDE hard disc drive, a 32-speed CD-ROM, an internal IDE ZIP drive, a Matrox Millennium II video card, a network card, an internal 56K modem and a 17-inch monitor.

The new machine was bought to play a central role in his office network but there was just one problem – it didn't work properly. In fact, it came with a number of faults, as follows: (1) the hard drive indicator LED was permanently lit; (2) the machine often hung at the Windows NT splash screen during boot up; (3) it was very slow to log on to other computers on the network and often missed some connections altogether; and (4) the modem didn't work.

Unfortunately, he didn't have time to take it back to the retailer to sort the problems out. He really needed to have the machine up and running that weekend for an important project that they were working on, which was how I got involved.

To begin, I decided to find out why the hard drive indicator LED was staying on, even when there was no drive activity. This turned out to be straightforward – the hard disc drive and the CD-ROM drive shared the primary IDE port but they were not correctly configured as master and slave. Instead, the hard disc drive was configured as a "single drive, no slave present", while the CD-ROM jumper was in the "master" position.

To make matters worse, the ZIP drive was on its own on the secondary IDE port but was configured as a slave. Who ever set this machine up obviously didn't have a clue about correctly configuring IDE drives in master/slave relationships.

To overcome the problem, the hard drive was left on the primary IDE port and the CD-ROM moved to the secondary IDE port, along with the ZIP drive. The jumper on the back of the ZIP drive was then set to the "master" position, while the CD-ROM was configured as the slave. After that, the indicator LED only lit when there was drive activity.

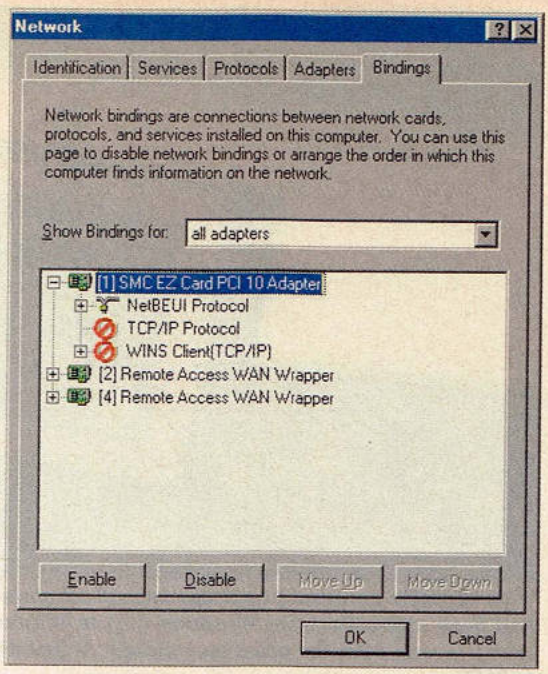


Fig.1: if you don't have NT Server and are using NetBEUI for your local area networking protocol, disable the TCP/IP bindings for the network card. If you don't, you will get an error message each time you boot up (ie, "The DHCP client could not obtain an IP address").

Of course, we could have left the CD-ROM on the primary IDE port had we wished. The hard drive would then have been configured as the master and the CD-ROM drive as the slave. However, it's best not to do this as having the CD-ROM drive on the same port as the hard disc drive can sometimes slow things down.

Problem number 2 – hanging at the Windows splash screen during boot-up – was tackled next. We figured that this could be a video driver problem, so we logged onto the Matrox web site, downloaded the latest driver for the Matrox Millennium II card and installed it as per the instructions. And that was it – the machine now booted into Windows NT every time, although it was still very slow to log onto the network.

The network problem was the next in line. The symptoms here were rather puzzling – why did it recognise some network connections on some occasions but not on others? And why was it always so slow to log onto the network?

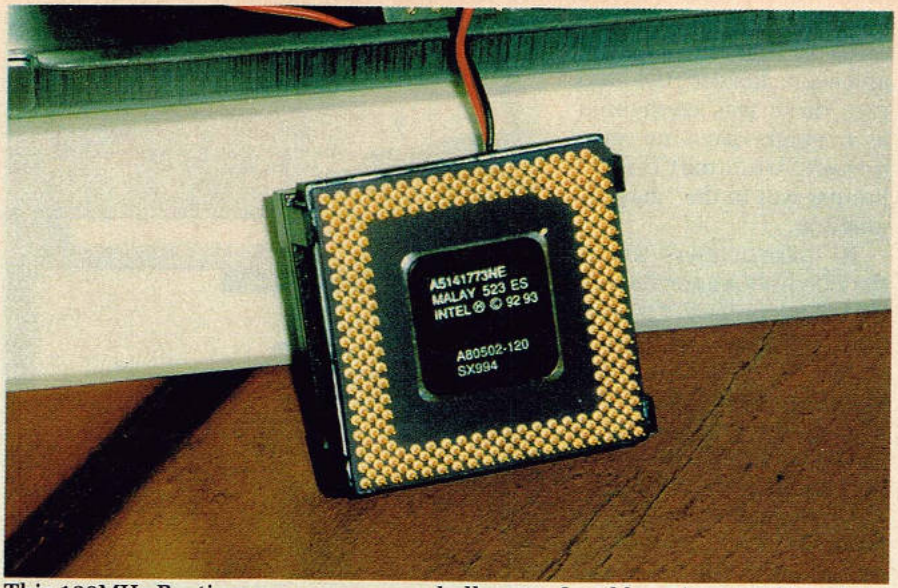
When the software settings all checked out, we tried reinstalling the driver for the network card but this made no difference. In the end, we decided to remove the network card for a closer inspection but it proved surprisingly difficult to remove from its slot on the motherboard. In fact, it was jammed in so tightly that it took a fair amount of force to free it.

The reason for this wasn't hard to find. The backplane blanks on this machine are normally secured by small metal "bridges" at either end and are removed by "knocking" them out. Unfortunately, this had badly distorted the backplane metalwork so that it pushed hard against the backplane bracket when the network card was inserted.

When the metalwork was straightened, we found that the network card now slid easily into its slot on the motherboard. What's more, the machine now quickly found all the network connections and logged on in the normal manner. Apparently, the network card had been forced so far sideways that it was only making intermittent contact with some of the slot contacts.

How the ham-fisted clots ever got the network card into its slot in the first place without breaking anything, I'll never know. Anyway, that was problem number three out of the way.

Just one further point here. If you aren't using NT Server and are using



This 120MHz Pentium processor caused all sorts of problems in a machine that had been upgraded from Windows 3.11 to Windows 95. There was nothing really wrong with the processor though; it just didn't like being overclocked at 133MHz.

NetBEUI as your local area networking protocol, be sure to disable the TCP/IP bindings for the network card, otherwise you'll get an error message each time you boot – see Fig.1.

Problem number four was the non-functioning modem. The problem here was that this was configured as a Plug and Play (PnP) device but Windows NT4 is not really a PnP operating system (unless you install the PNP drivers). We changed the jumpers to turn the PnP feature off, then checked that the other jumpers set the modem to COM2 IRQ3 (as set out in the manual).

This done, we reinstalled the modem and disabled the external COM2 port in the system BIOS (note: if you don't do this, you can get conflicts with an internal modem card that's set to COM2, even if there's nothing connected to the external port). Finally, we installed the modem driver software as instructed in the manual, after which the modem worked perfectly.

After that, it was mainly a matter of tidying things up. For starters, the internal cabling to the disc drives was quite messy and I spent some time rerouting the cables to tidy things up and to eliminate any strain on the connectors. I also noticed that the vendor had only installed Service Pack 1 for the NT Workstation operating system, despite the fact that Service Pack 3 has been out for ages.

We installed Service Pack 3 without any problems, the only glitch being that this wipes out the ZIP drive installation. That problem was overcome by reinstalling the drivers for the ZIP drive, following the step-by-step procedure listed in the manual. We then finished off by changing the screen resolution from the vendor's 640 x 480 setup to 1152 x 864. This is something the vendor should have done as a matter of course, given the hardware involved (8MB Matrox Millennium II graphics card and 17-inch monitor).

All in all, the whole exercise involved several hours of work that should not have been necessary. The problems that this machine had were all too obvious. Either the vendor neglected to test the machine properly or if they did, they lacked sufficient technical expertise to recognise the problems and fix them. Or maybe the person who set it up just didn't care.

In the end though, it's the retailer who will lose out. Guess where my friend won't be buying his next computer!

The overclocked Pentium

My last story concerns a Pentium 133MHz machine that was purchased several years ago, again by a friend who runs a small business. It came complete with 32MB of RAM, a sound card, a network card, a CD-ROM drive, Windows 3.11 – and the Sepultura virus! Fortunately, the virus was discovered immediately and cleaned off before it had done any harm.

The machine worked fine under Windows 3.11 but all sorts of problems arose when the operating system was eventually upgraded to Windows 95. System crashes were a common problem and the machine also often refused to close down properly. On other occasions, it would even refuse to boot correctly.

Eventually, the machine landed on my desk and many hours were wasted trying to solve the problem. Initially, we suspected a software problem so we stripped the machine down to its bare essentials and removed all unnecessary drivers. When this didn't help, we tried upgrading the video driver but again drew a blank.

Next, we backed up the data, reformatted the drive and reinstalled the operating system. That didn't help either but one thing was becoming apparent – instability problems only arose after the machine had been running for some time with the lid on.

Based on this observation, we decided that the fault must be heat sensitive. We tried swapping the RAM and the video card over from an identical machine without result and then noticed that the processor in the crook machine ran much hotter than the processor in its twin.

The full story was revealed when we removed the processor from its ZIF socket and inspected the markings on the underside. It wasn't a 133MHz CPU as ordered but a 120MHz CPU that was being overclocked! We changed the bus speed from 66MHz to 60MHz (so that the processor now ran at 120MHz instead of 133MHz) and that solved all our problems.

Understandably, my friend was furious but his subsequent complaint to the retailer about the processor mix up was badly handled. There was no apology nor any offer of compensation, although they did eventually agree to exchange the CPU. But it was all too little too late. In fact, my friend was so annoyed at what had happened and by their attitude that he seriously considered taking legal action to recover his costs.

In the end, he simply decided to get even. His company has purchased several new machines over the last few years and will buy lots more in the future. Guess who doesn't get the orders? **SC**

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FM antenna problems

I made two 5-element FM antennas as described in the March 1998 issue and I have several questions concerning them. I have a fairly old JVC portable stereo system. It has a 4-band tuner, AM/FM, etc. It has twin telescopic aerials as most do and also has two antenna connections at the back for FM. I connected one of the antennas I made to it with 75Ω ribbon. The connection is for 75Ω. This gave no great improvement although the antenna is pointed in the right direction in respect to the signal.

Secondly, my bedside clock radio is a Sony IC5-SW7600 all world band AM/FM. I wanted to improve the FM reception so I made a second antenna, mounting it atop a 3-metre pole on the roof. Again I only used ribbon, carefully strung away from the corrugated iron roof. The radio has a mini 300-75Ω plug on the side. If anything it tends to dull the signal.

For shortwave reception I also strung up a long wire between a pole mounted on the facia to a tree in the back yard. It works great! In fact I think it tends to override the purpose of the FM antenna. Have I got too many antennas?! With this long range antenna I can pick up WWVH Maui in Hawaii quite clearly.

Can you tell me what happens when you divide up this long range antenna and connect it to the both radios at once? A local electronics guy says the only way to have good FM is to use a car radio as he says they have a much better circuit and are a more powerful receiver. Is this so? (A. B., Proserpine, Qld).

● If your portable combo has two FM connections, the likelihood is that they are intended for 300Ω ribbon cable rather than 75Ω coax cable. There is no such thing as 75Ω ribbon. If you have hooked up 75Ω coax to the 5-element antenna you should use a 300Ω to 75Ω balun connection otherwise there will be mismatch problems.

In your location, the shortwave antenna may pick up more signal than the FM antenna but that may be a function of the antenna connections on your receiver. Good car radios generally do have a very sensitive FM front end but it would not be superior to those on good quality hifi FM stereo tuners. The antenna connection to a car radio should be made via 75Ω coax cable.

Queries on the class-A amplifier

I intend building the Opus One speakers described in the August 1998 issue. Would there be any advantage in replacing the 10µF bipolars with poly types which I have in my junk box, assuming there's room on the boards?

I am also interested in the class-A amplifier described in the July & August 1998 issues. I assume this will become a kit with case and power supply; at the moment it's only sold as a power amplifier module. Wouldn't it be better to leave out the headphone socket and volume control in order to get even better performance?

Regarding the power transformer, there doesn't seem to be a 21V transformer, with the usual catalogs going from 18V to 25V. Would a 25V transformer be OK? As the supply is regulated, I can't see any reason why the few extra volts would be a problem as

Extending transmitter range

I have a wireless door chime which I have given to an aunt who is bedridden. She can use it to summon whoever is in the house for help. While it works well when whoever is wearing the receiver is inside the house, it does not work if we happen to be outside in the garden.

Is there anything I can do to modify the transmitter or receiver to increase the range? I would prefer not to make any major modifications because I want everything to fit inside the existing cases.

Can you help? (K. A., Warriewood, NSW).

● In our experience, it is an easy matter to modify these wireless door chimes to increase the range. Typically they operate at about 300MHz. All you have to do is to put a bigger antenna on the receiver and this is simply a matter of connecting a piece of insulated hookup wire to the receiver's input. A piece about 40-50cm long should do the trick although you may have to experiment to determine the optimum length.

First, unclip the receiver case and identify the input of the receiver. This will usually have a small coil as the antenna and often this will be part of the copper pattern of the board. Now unclip the battery and then solder a length of the insulated hookup wire to the input. Finally, clip the battery back in place and verify that the door chime still works when you press the button on the transmitter.

If it works, then arrange for the antenna wire to dangle outside the case (you may need to drill or cut a small exit hole for the wire). Check the working range. It should be possible to obtain a range of about 100 metres or more.

On the other hand, if the door chime does not work with the wire extension, restore everything as it was and make it work again. Then check that you made the connection to the right place. You may also need to use a shorter length of wire.

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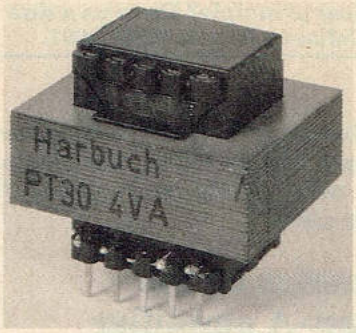

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I assume the mains supply could vary by more than this and it means no mucking about with mods to the transformer.

If I do have to use the 18V transformer could you give a bit more detail on how to add the extra turns as I'm not quite clear from the article how this is done? (P. G., Orient Point, NSW).

● Plastic dielectric capacitors are superior to bipolar electrolytic capacitors and it is worth replacing them in any loudspeaker crossover network.

The class A amplifier and its power supply are now available as a kit from Altronics of Perth. There is no need to include the headphone socket but the volume control is worth keeping. This amplifier is so good that it will sound better being driven directly by a CD player than with virtually any other control unit driving it and that includes any previous SILICON CHIP designs.

A 25V-0-25V transformer will produce far too much voltage for the regulator circuitry and will cause it to severely overheat. It is a relatively straightforward matter to add the required extra turns over the existing winding, as described on page 79 of the August 1998 issue. The main difficulty is that the 1.25mm enamelled wire is rather stiff and unwieldy.

SLA/NiCd battery for photoflash

I earn my living as a freelance journalist/photographer and have the latest you-beaut Nikon camera setup with flash. The only trouble is that I often need to use the flash at full output to get the maximum depth of field. I find that this means that the four alkaline AA cells can be noticeably discharged before I finish a roll of film. The inbuilt charge indicator on the cells (Duracell) still says that the batteries are up to the job but the flash takes too long to recharge, which can be a problem when you are "bracketting" the shots.

I have thought of using an external battery pack of course but the one to suit my flash costs more than a thousand dollars. My next thought was to use NiCd cells but they would need recharging often while I am on the job. I wonder if I could then have a setup whereby I connected a 6V SLA battery in parallel with the 4 AA NiCd cells to rapidly recharge them. That way I wouldn't be loaded down with an external battery pack all the time. What do you think? (J. D. Para Hills, SA).

● If you connect a fully charged SLA battery in parallel with four NiCd cells, you will end up with an explosion – that's what we think! It would blow your precious photoflash to smithereens.

If you can't afford to buy the proper external battery pack, we suggest you take a look at the article on making your own in the October 1998 issue.

Remote control interference

Some six months ago, I noticed that my Sanyo CPP2621SV-00 colour television infrared remote control was becoming sluggish when you pushed a button to change channels, volume, etc. The LED near the channel indicator on the front of the set would illuminate but no channel or volume change would occur. Within 3-10 seconds with the relevant remote button held down, the desired change would occur.

Eventually my wife said do something to fix it or I'm getting someone to look at it! These were fighting words to stir the blood! One Saturday afternoon I decided to remove the remote control preamp (UG0007) from the set for investigation of dry solder joints and component and voltage checks. All component and voltage checks were OK but as it contained some seven electrolytics and polyester capacitors and as I thought one of them might be leaky, they were changed. Upon start up, the set worked normally and I was back in the good books with my wife.

Later that night it was back to square one. Must be heat sensitive said I. I'll look into it tomorrow. On Sunday at about 4 o'clock I came home to watch the last hour of a motor racing program and stood up in the middle of the room and activated the remote. The set turned on but was on the wrong channel and the volume was down. I pushed the relevant buttons and everything worked normally. I then sat down and continued to adjust the volume and it would not respond – back to square one again!

I then stood up again in the same position as when I first walked into the room and all the functions on the remote worked perfectly. I stood and looked back to a light on the wall behind me and the light came on – in my head that is! I have been reading the series on lighting in SILICON CHIP

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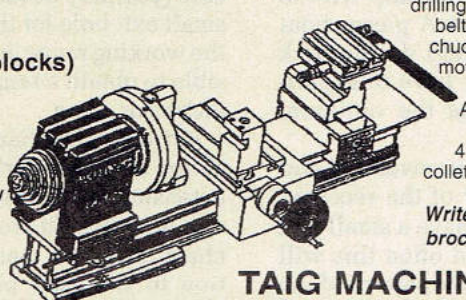

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Sports ignition coils not recommended

I have built several of the High Energy Ignition systems as described in the May and June 1988 issues of SILICON CHIP for mates of mine and they have all been pleased with them. Now I am about to build the latest version of the circuit, as published in June 1998 for another friend of mine but he wants to use it with a "sports" coil. Is there any advantage in doing this or could there be any problems? (B. R., Para Hills, SA).

● This question has arisen on a number of occasions in the past with the early versions of the circuit and the answer has been that we strongly advise against using a "sports coil" with the high energy ignition. The reason is that sports coils draw substantially higher current to obtain their higher output voltage but when combined with our HEI circuit they draw even more current because of the inbuilt "dwell extension". This means that the HEI switching transistor may overheat and the coil itself could overheat to the extent that it may be damaged.

So if you are building any of the original circuits, don't use a sports coil. On the other hand, if you are building the revised version of the HEI system, as published in the June 1998 issue, the issue of the current drain is not important. This is because the circuit has inbuilt current limiting, set to 5A. However, because the current is fixed to maximum of 5A, there is still no advantage in paying the extra price for a sports coil.

Much the same comment applies if you are building the Multi-Spark CDI system described in the September 1997 issue – the amount of energy dumped into the primary is not affected by the coil's resistance and therefore there is no benefit in a sports coil.

and remembered the pie charts with IR, visible, UV and C&C energy outputs. Could it be that the light is producing an IR level that is affecting the set?

Removal of the light globe confirmed the problem. It was a compact fluorescent Philips PLC Electronic 9W which had obviously undergone some change to its IR level so that it interfered with the remote sensor receiver on the set.

Interestingly it did not interfere with my CD remote or sensor. I enclose the offending light which still works and would appreciate some feedback if you come up with any answers as to what occurred with the light to make it cause the interference. (F. W., Airport West, Vic).

● We can think of two possibilities as to why the CFL (compact fluorescent lamp) does cause interference. First, as the lamp ages and its filaments erode and are deposited on the glass envelope, its IR output will no doubt increase as its visible light falls.

Secondly, and more importantly, we measured the frequency radiated by your CFL. It radiates very strongly with a fundamental at around 48kHz and with harmonics ranging up into the shortwave region. We wonder if it would pass today's EMC regulations. The 48kHz fundamental is possibly strong enough to swamp the IR remote control receiver directly. Alternatively, it is almost certainly modulating the IR output of the lamp and could be swamping the remote control circuits in that way.

Either way, you've worked out the solution – turn off the lamp if you want remote control!

Notes & Errata

Low-Cost Electric Fence Controller, July 1995: a number of readers have complained about insufficient HT output from this circuit. We have now been advised by Dick Smith Electronics that the resistance of the 250mA fuse can be critical in this respect. Typical 250mA fast-blo fuses have a resistance of 11Ω and this will have a large effect on the HT output. To avoid this problem, we suggest using a 500mA fuse; typically these have a resistance of less than 1Ω.

Chook Raffle/Random Number Generator, April 1998: if this program generates a number of less than four digits, the previous 4th digit is not erased, even though the correct value is written into the draw. The following lines will correct this anomaly:

```
3260 LOCATE R,C: PRINT FNCEOL$
3270 FOR AA = 1 TO 4: LOCATE CSRLIN,
     C: PRINT FNCEOL$: NEXT
```

Recommendation against sports ignition coils

High Energy Ignition, May 1988; Breakerless Ignition, June 1988; High Energy Ignition for Reluctor Distributors, May 1990: we recommend against using sport ignition coils such as the commonly available "GT40". These coils draw more current than the original vehicle's coil and may seriously overheat.

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely. Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

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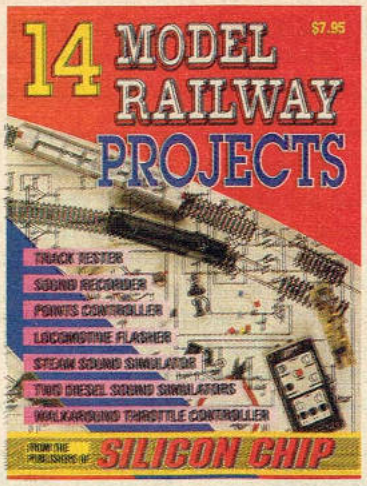

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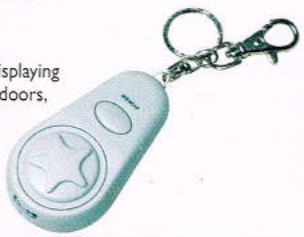

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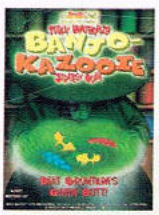

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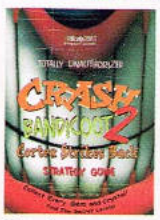

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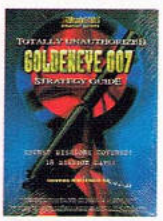

Totally Unauthorised GoldenEye

B 9714

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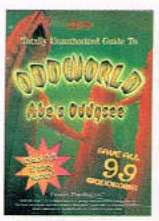

Oddworld: Abe's Odyssey

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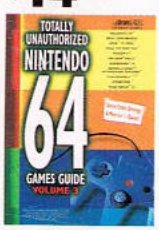

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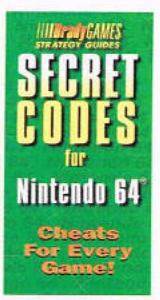

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